PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2002-174929
(43)Date of publication of application : 21.06.2002

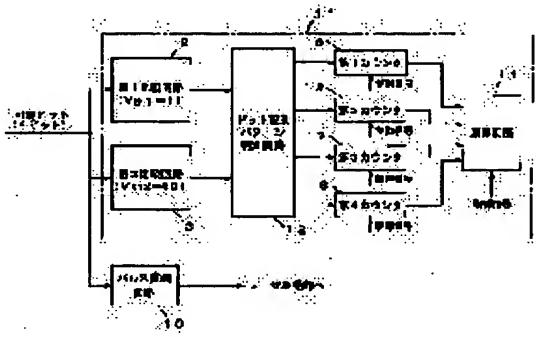
(51)Int.Cl. G03G 15/00
B41J 2/44
G03G 15/01
G03G 15/08

(21)Application number : 2000-370962
(22)Date of filing : 06.12.2000

(71)Applicant : SEIKO EPSON CORP
(72)Inventor : SUGITA TAKATOSHI
YAMADA YOSHIKO

(54) METHOD AND DEVICE FOR DETECTING TONER CONSUMPTION

(57)Abstract:
PROBLEM TO BE SOLVED: To accurately obtain each color toner consumption with a simple constitution as for a color laser printer.
SOLUTION: A printing dot having a gradation value of ≥1 is outputted by a 1st comparison circuit 2, and a printing dot having a gradation value of ≥48 is outputted by a 2nd comparison circuit 3. A count value 1 is outputted to a 1st counter 5 by a dot arrangement pattern discrimination circuit 12 whenever the printing dot having the gradation value of ≥48 is detected, and a count value 1 is outputted to a 2nd counter 13 whenever the generation of three continuous dots is detected, and a count value 1 is outputted to a 3rd counter 7 whenever an isolated dot is detected, and a count value 1 is outputted to a 4th counter 8 whenever the printing dot having the gradation value of ≥1 is detected. When the count value 1 is separately outputted to the 1st counter 5, the 2nd counter 13, the 3rd counter 7 and the 4th counter 8 by the discrimination circuit 12, an operation of counting up by one is performed by each counter. The toner consumption is calculated by using a prescribed expression by a calculation circuit 14 based on the counted values given from the 1st to 4th counters.



LEGAL STATUS

[Date of request for examination] 06.08.2003
[Date of sending the examiner's decision of rejection]
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]
[Date of final disposal for application]
[Patent number]
[Date of registration]
[Number of appeal against examiner's decision of rejection]
[Date of requesting appeal against examiner's decision of rejection]
[Date of extinction of right]

CLAIMS

[Claim(s)]
[Claim 1] A toner consumption detection method which divides a printing dot train into three patterns, an isolated dot, 2 continuation dot, and a mean value dot, carries out counting of the number of an isolated dot, a count of generating of 2 continuation dot, and the number of a mean value dot about an image of each color printed at a period of a predetermined unit, and is characterized by calculating consumption of a toner of each color recorded on a record form based on those enumerated data.
[Claim 2] A printing dot train about an image of each color printed at a period of a predetermined unit An isolated dot, It divides into four patterns of 2 continuation dot, 3 continuation dot, and a mean value dot. A toner consumption detection method which carries out counting of the number of an isolated dot, a count of generating of 2 continuation dot, a count of generating of 3 continuation dot, and the number of a mean value dot, and is characterized by calculating consumption of a toner of each color recorded on a record form based on those enumerated data.
[Claim 3] Toner consumption detection equipment characterized by providing the following. The 1st comparison circuit which compares the 1st threshold with a value of a printing dot The 2nd comparison circuit which compares the 2nd larger threshold than the 1st threshold with a value of a printing dot An operation means to calculate consumption of a toner of each color which divided a printing dot train into three patterns, an isolated dot, 2 continuation dot, and a mean value dot, carried out counting of the number of an isolated dot, a count of generating of 2 continuation dot, and the number of a mean value dot based on an output of the 1st comparison circuit and the 2nd comparison circuit, and was recorded on a record form based on those enumerated data
[Claim 4] Toner consumption detection equipment characterized by providing the following. The 1st comparison circuit which compares the 1st threshold with a value of a printing dot The 2nd comparison circuit which compares the 2nd larger threshold than the 1st threshold with a value of a printing dot An operation means to calculate consumption of a toner of each color which divided a printing dot train into three patterns of an isolated dot, 2 continuation dot, 3 continuation dot, and a mean value dot, carried out counting of the number of an isolated dot, a count of generating of 2 continuation dot, a count of generating of 3 continuation dot, and the number of a mean value dot based on an output of the 1st comparison circuit and the 2nd comparison circuit, and was recorded on a record form based on those enumerated data

---

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] This invention relates to the method and equipment which calculate the consumption of the toner of each color with a sufficient precision with an easy configuration in color picture formation equipments, such as a color laser beam printer which forms an electrostatic latent image in a photo conductor by the light beam modulated with print data, and the color toner which is a record material is made to stick to this electrostatic latent image electrostatic, and forms an image in a record form.
[0002]
[Description of the Prior Art] In the equipment which performs color picture formation using color toners, such as a color laser beam printer, it is requested to the user that the consumption or the residue of a toner of yellow (Y), a Magenta (M), cyanogen (C), and black (K) is shown. [of each color] For that purpose, although the toner of each color needs to detect which was consumed every whenever it performs color picture formation In color picture formation equipment in recent years, many gradation, i.e., 1 printing dot, is made for each dot (this is called a printing dot) actually printed by the record form with two or more bit configuration. Moreover, the value of a printing dot, Since the relation with the amount of toners consumed is nonlinear, it is made very difficult to detect the toner consumption of each color of C, M, Y, and K which are consumed when color picture formation is performed.
[0003] Although it is known well that the value of a printing dot and the relation of toner consumption are nonlinear, the following occurs, for example. Although it is common that the Pulse-Density-Modulation (PWM) method which generates the pulse which has the width of face according to the value of a printing dot as a pulse modulation method, and controls the luminescence time amount of a laser beam by current color picture formation equipment is adopted It is known that the relation between the width of face of the pulse outputted from the laser luminescence time amount, i.e., PWM circuit, when printing only the printing dot of a piece and the amount of toners consumed by the printed dot comes to be shown as the continuous line of a schematic diagram 7 . Since laser luminescence time amount responds to the value of a printing dot, it can be said that the above thing means that the relation between the value of a printing dot and toner consumption is nonlinear.
[0004] However, the relation shown as the continuous line of drawing 7 always is not realized. For example, though the toner consumption when printing only one printing dot of a certain value independently is Xmg, the amount of toners required for printing the printing dot concerned depending on the value of the printing dot adjoined before and behind the printing dot concerned differs from Xmg. Thus, also when printing only one printing dot independently, the value of a printing dot and the relation of the amount of consumption toners are nonlinear, and the amount of toners consumed when printing the printing dot concerned further also with the value of the printing dot adjoined before and behind that has a very complicated phenomenon [say / change].
[0005] This invention was made in view of the above situations, and also in the color picture formation equipment whose 1 printing dot is two or more bit configuration, it is an easy configuration and it aims at offering the toner consumption detection method and equipment which it is moreover accurate and can detect the consumption of the toner of each color of C, M, Y, and K.
[0006]
[Means for Solving the Problem] In order to attain the above-mentioned object, the 1st toner consumption detection method concerning this invention About an image of each color printed like at a period of a predetermined unit according to claim 1 A printing dot train is divided into three patterns, an isolated dot, 2 continuation dot, and a mean value dot, counting of the number of an isolated dot, a count of generating of 2 continuation dot, and the number of a mean value dot is carried out, and it is characterized by calculating consumption of a toner of each color recorded on a record form based on those enumerated data. Moreover, the 2nd toner consumption detection method concerning this invention About an image of each color printed like at a period of a predetermined unit according to claim 2 A printing dot train is divided into four patterns, an isolated dot, 2 continuation dot, 3 continuation dot, and a mean value dot. Counting of the number of an isolated dot, a count of generating of 2 continuation dot, a count of generating of 3 continuation dot, and the number of a mean value dot is carried out, and it is characterized by calculating consumption of a toner of each color recorded on a record form based on those enumerated data. The 1st toner consumption detection equipment concerning this invention The 1st comparison circuit according to claim 3 which compares the 1st threshold with a value of a printing dot like, The 2nd comparison circuit which compares the 2nd larger threshold than the 1st threshold with a value of a printing dot, It is based on an output of the 1st comparison circuit and the 2nd comparison circuit. A printing dot train An isolated dot, It

divides into three patterns of 2 continuation dot and a mean value dot, counting of the number of an isolated dot, a count of generating of 2 continuation dot, and the number of a mean value dot is carried out, and it is characterized by having an operation means to calculate consumption of a toner of each color recorded on a record form based on those enumerated data. Moreover, the 2nd toner consumption detection equipment concerning this invention The 1st comparison circuit according to claim 4 which compares the 1st threshold with a value of a printing dot like, The 2nd comparison circuit which compares the 2nd larger threshold than the 1st threshold with a value of a printing dot, It is based on an output of the 1st comparison circuit and the 2nd comparison circuit. A printing dot train An isolated dot, It divides into three patterns, 2 continuation dot, 3 continuation dot, and a mean value dot. Counting of the number of an isolated dot, a count of generating of 2 continuation dot, a count of generating of 3 continuation dot, and the number of a mean value dot is carried out, and it is characterized by having an operation means to calculate consumption of a toner of each color recorded on a record form based on those enumerated data.

[0007]

[Embodiment of the Invention] Hereafter, the gestalt of implementation of invention is explained, referring to a drawing. By the way, since the relation between the value of a printing dot and the amount of consumption toners is nonlinear as mentioned above, it will become difficult for it to detect toner consumption paying attention to the value of a printing dot. Then, this invention person found out two methods of the printing dot train to input being the array of the printing dot of what kind of value without paying attention to value itself of each printing dot, or detecting toner consumption paying attention to the pattern of the array as a result of various experiments. The 1st method is a fundamental method and the 2nd method is amelioration of the 1st method. In addition, an experimental result is shown later.

[0008] [the 1st toner consumption detection method] -- the 1st method is explained first. It sets to this method and they are two thresholds Vth1 and Vth2 to the value of a printing dot. It sets and the pattern division of the array pattern of a printing dot train is carried out at three kinds. The 1st threshold Vth1 It is for distinguishing and sets to Vth 1= 1 whether to be that to which a printing dot consumes a toner with the gradation value of a printing dot. The 2nd threshold Vth2 Although it is for distinguishing whether a gradation value is above to some extent and can set suitably by the bit pattern of a printing dot, when 1 printing dots are 6 bit patterns, it is checked by experiment that it is good to be referred to as about 2= 48 Vth with the gradation value of a printing dot. About this, the example of a comparison is shown later. In fact, when 1 printing dots are 6 bit patterns, as P shows Vth 2= 48 in drawing 7 , supporting the gradation value near [with the longer laser luminescence time amount in the graph which shows the relation between laser luminescence time amount and toner consumption] the point of inflection is checked.

[0009] And the pattern division of the pattern of the array of a printing dot train is carried out at the following three kinds.

** Isolated dot -- Printing dot both whose gradation values of the printing dot before and behind that it is the printing dot whose gradation value is beyond the 2nd threshold, and are under the 2nd threshold. Such a printing dot is called an isolated dot.

** 2 continuation dot -- When two printing dots whose gradation values are beyond the 2nd threshold continue. This case is called 2 continuation dot.

** Mean value dot -- Printing dot whose gradation value is under the 2nd threshold above the 1st threshold. Such a printing dot is defined as a mean value dot.

[0010] thus, carrying out a pattern division -- an outline -- it is as follows. The printing dot whose value is beyond the 2nd threshold differs in toner consumption clearly from a mean value dot so that he can understand easily also from drawing 7 . Then, the validity of a value dividing into the thing beyond the 2nd threshold and the mean value dot below it first is clear. Next, about distinguishing an isolated dot and 2 continuation dot, it is as follows. For example, suppose that it turns out about a certain color that the toner consumption when printing only one printing dot of the maximum gradation independently is Xmg. Supposing it prints 2 dots of printing dots of the maximum gradation continuously at this time, it is known that the consumption of the toner of the color concerned at this time will increase more than that instead of twice of Xmg a little. According to such a situation, even if a value is a printing dot beyond the 2nd threshold, the pattern division of the case where two cases where it is isolated are followed is carried out.

[0011] And C of the image printed at the period of an unit with proper 1-page unit or job unit etc., For every image of each color of M, Y, and K, carry out counting of the number of an isolated dot, the count of generating of 2 continuation dot, and the number of a mean value dot, and each of the three enumerated data is received. Carry out the multiplication of the coefficient of weighting to each pattern, and these three values are added. By carrying out the multiplication of the coefficient according to the color of a toner to the aggregate value, the consumption of the toner of each color recorded on the record form is calculated, the amount of offset is applied to it and the total amount of toners of each color then consumed is calculated.

[0012] Here, the amount of offset is the amount of toners consumed regardless of the exposure time by the laser beam, and it is characteristic characteristic value for every color picture formation equipment. That is, if a photo conductor is cleaned also when a pure white image is printed, it is known that some toners will be discharged. This is the amount of offset. Since this amount of offset changes with colors, the amount of offset is measured about the toner of each color of C, M, Y, and K, respectively.

[0013] Specifically, it is as follows. Now, the toner consumption of each color shall be detected per 1 page. Moreover, the process of color picture formation shall be performed in order of C, M, Y, and K.

[0014] In this case, counting of the number of an isolated dot, the count of generating of 2 continuation dot, and the number of a mean value dot is first carried out about the printing dot of the image of C color which carries out a sequential input. For example, it carries out to it seeming that the printing dot train of the image of C color shows now drawing 1 (a). In drawing 1 (a), 1 printing dot presupposes that it is 64 gradation in 6 bit patterns, and is taken as the 1st threshold Vth 1= 1 and the 2nd threshold Vth 2= 48. And a rectangle shows each printing dot and the numeric value in a rectangle shows the gradation value of each printing dot. Moreover, in drawing 1 (a), the number of 1-14 is attached to the printing dot for convenience.
[0015] Now, in drawing 1 (a), since it is beyond the 2nd threshold since the gradation value of the 2nd printing dot is 60, and both the gradation values of the printing dot before and behind that are under the 2nd threshold in 40 and 20, the 2nd printing dot is an isolated dot. The 13th printing dot is an isolated dot similarly. The black dot of the column of the isolated dot of drawing 1 (b) shows this.
[0016] Moreover, the gradation value of the 6th printing dot is beyond the 2nd threshold, and the gradation value of the 7th following printing dot is also beyond the 2nd threshold. Therefore, since the printing dot beyond the 2nd threshold is following [the gradation value] the 6th and the 7th, 2 continuation dot has occurred once here. It shows this that the black dot is attached to the part of the 7th printing dot of the column of 2 continuation dot of drawing 1 (b). Similarly, since both the gradation values of the 7th and the 8th printing dot are beyond the 2nd threshold, 2 continuation dot has occurred once also here. It shows this that the black dot is attached to the part of the 8th printing dot of the column of 2 continuation dot of drawing 1 (b). It is the same as that of the following. Moreover, the black dot of the column of the mean value dot of drawing 1 (b) comes to show a mean value dot by the above-mentioned definition. Therefore, in the case of drawing 1 (a), the enumerated data of the number of 4 and a mean value dot are set [the enumerated data of the number of an isolated dot] to 6 by the enumerated data of the count of generating of 2 and 2 continuation dot.
[0017] And the multiplication of the weighting coefficient to each pattern is carried out to each of these three enumerated data, and those three values are added to it. And the multiplication of the coefficient of the toner of C color is further carried out to the aggregate value, the amount of offset is further applied to the multiplication value, and the amount of toners of C color then consumed is calculated. Therefore, the consumption of 1 concerned page C color toner is a weighting coefficient [as opposed to the pattern of k2 and a mean value dot for a weighting coefficient / as opposed to the pattern of k1 and 2 continuation dot for the weighting coefficient to the pattern of an isolated dot] k3 It carries out and is Kc about the coefficient of the toner of C color. It carries out. C color toner consumption = Kc x[k1 x (enumerated data of the number of an isolated dot)
+ k2 x (enumerated data of the count of generating of 2 continuation dot)
+ k3 x(enumerated data of the number of mean value dot)]
+ The amount of offset of C color toner — It is set to (1).
[0018] Next, although the sequential input of the printing dot of the image of M color is carried out, counting of the number of an isolated dot, the count of generating of 2 continuation dot, and the number of a mean value dot is similarly carried out to the printing dot of the image of M color. And the multiplication of the predetermined coefficient is carried out to these three enumerated data, respectively, these three values are added, the amount of offset is further applied to the aggregate value, and the amount of toners of M color then consumed is calculated. Therefore, the consumption of 1 concerned page M color toner is Km about the coefficient of the toner of M color. If it carries out M color toner consumption = Km x[k1 x (enumerated data of the number of an isolated dot)
+ k2 x (enumerated data of the count of generating of 2 continuation dot)
+ k3 x(enumerated data of the number of mean value dot)]
+ The amount of offset of M color toner — It is set to (2).
[0019] The same is said of the printing dot of the image of following and Y color, and the printing dot of the image of K color. Therefore, the consumption of 1 concerned page Y color toner and the consumption of K color toner are Kk about the coefficient of the toner of Ky and K color in the coefficient of the toner of Y color. It carries out and is each. Y color toner consumption = Ky x[k1 x (enumerated data of the number of an isolated dot)
+ k2 x (enumerated data of the count of generating of 2 continuation dot)
+ k3 x(enumerated data of the number of mean value dot)]
+ The amount of offset of Y color toner — (3) K color toner consumption = Kk x[k1 x (enumerated data of the number of an isolated dot)
+ k2 x (enumerated data of the count of generating of 2 continuation dot)
+ k3 x(enumerated data of the number of mean value dot)]
+ The amount of offset of K color toner — It is set to (4).
[0020] In addition, the coefficient Ky of the weighting coefficient k1 to each above-mentioned pattern, k2, k3, and the toner of each color, Km, Kc, and Kk A value The amount of toners of each color which printed about various images and was then printed by the record form is surveyed. The surveyed amount of toners, What is necessary is just to set based on the relation between the number of the isolated dot of the printing dot train of each color of the image printed at that time, the count which 2 continuation dot generates, and the number of a mean value dot etc.
[0021] Although the value of the weighting coefficient k1 to three patterns, k2, and k3 shall use the same value by the above-mentioned (1) - (4) formula, since a property changes with colors of a toner, the weighting coefficient to the pattern of an isolated dot, the weighting coefficient to the pattern of 2 continuation dot, and the weighting coefficient to the pattern of a mean value dot may be changed by the color of a toner. Moreover, in the above-

mentioned explanation, although the 2nd threshold made all the same about C, M, Y, and K, it may be changed by the color.
[0022] thus, various consumption of the toner of each color for which it asked can be boiled and used. For example, when the color picture formation equipment concerned is connected to the personal computer, the calculated toner consumption is passed to a personal computer, toner consumption is integrated and memorized by the personal computer side, and it can display as a bar graph at the time of printing.
[0023] Since it is above, by this toner consumption detection method The pattern of the printing dot train of each color of a printing image An isolated dot, 2 continuation dot, It divides into three kinds of mean value dots. The number of an isolated dot, the count of generating of 2 continuation dot, Carry out counting of the number of a mean value dot, and carry out the multiplication of the weighting coefficient to each pattern to these three enumerated data, and it is added to them. The multiplication of the coefficient according to the color of a toner is carried out to the aggregate value, and since what is necessary is just to perform processing in which the amount of offset is added to the multiplication value, it is realizable with an easy configuration so that it may mention later. Moreover, since this toner consumption detection method detects toner consumption based on a printing dot train, it is not based on the pulse modulation method which generates the pulse for driving a laser beam, but can be applied also to the equipment which uses a Pulse-Amplitude-Modulation (Pulse Amplitude Modulation) method also for the equipment using PWM, or the equipment of the hybrid configuration which combined PWM and Pulse Amplitude Modulation.
[0024] One operation gestalt of [the toner consumption detection equipment which adopted the 1st toner consumption detection method], next the toner consumption detection equipment which detects toner consumption by the toner consumption detection method mentioned above is explained. In addition, 1 printing dot presupposes that they are 6 bit patterns here.
[0025] Drawing 2 is drawing showing the partial block diagram of 1 operation gestalt at the time of applying toner consumption detection equipment to a color laser beam printer. 1 — toner consumption detection equipment and 2 — the 1st comparison circuit and 3 — the 2nd comparison circuit and 4 — a dot array pattern distinction circuit (a distinction circuit is only called hereafter) and 5 — in the 1st counter and 6, the 4th counter and 9 show an arithmetic circuit and, as for the 2nd counter and 7, 10 shows a pulse modulation circuit, as for the 3rd counter and 8. In addition, a color laser beam printer presupposes that it is the thing of the type with which the development counter of four colors of C, M, Y, and K has been arranged around one photo conductor here. In this type of color laser beam printer, it is common knowledge to form the electrostatic latent image of four colors of C, M, Y, and K in one photo conductor by one laser beam. Moreover, the configuration of this type of the whole color laser beam printer is common knowledge, and since it moreover is not the essence of this invention, in drawing 2 , the graphic display is omitted about the photo conductor or the development counter.
[0026] Hereafter, each part shown in drawing 2 is explained. The 1st comparison circuit 2 is the value and the 1st threshold Vth1 of a printing dot to input. It compares, the printing dot which has a value beyond the 1st threshold is outputted to the distinction circuit 4, and it is this 1st threshold Vth1. It is 1 in a gradation value.
[0027] The 2nd comparison circuit 3 is the value and the 2nd threshold Vth2 of a printing dot to input. It compares, the printing dot which has a value beyond the 2nd threshold is outputted to the distinction circuit 4, and it is the 2nd threshold Vth2 here. It is referred to as 48 with a gradation value.
[0028] The distinction circuit 4 is based on the train of the value of the printing dot by which a sequential input is carried out from the 1st comparison circuit 2 and the 2nd comparison circuit 3. When the value of a printing dot is beyond the 1st threshold and the value of a printing dot is beyond the 2nd threshold, It is what distinguishes the case where it is four in the case of being an isolated dot when 2 continuation dot has occurred. Whenever a gradation value detects the printing dot beyond the 2nd threshold, 1 is outputted to the 1st counter 5 every. Whenever it detects that 2 continuation dot occurred, 1 is outputted to the 2nd counter 6 every, whenever it detects an isolated dot, 1 is outputted to the 3rd counter 7 every, and whenever it detects the printing dot whose gradation value is beyond the 1st threshold, 1 is outputted to the 4th counter 8 every. Therefore, about 48 or more printing dots whose gradation values are the 2nd threshold, 1 will be outputted to both the 1st counter 5 and the 4th counter 8 at least in this case.
[0029] The 1st counter 5, the 2nd counter 6, the 3rd counter 7, and the 4th counter 8 will perform actuation which counts up only 1, respectively, if the distinction circuits 4-1 are outputted. In addition, a control signal is notified to these four counters from the control section which manages processing of the color picture formation which is not illustrated, respectively. There are a start signal which notifies transfer initiation of a printing dot, and an end signal which notifies transfer termination of a printing dot in this control signal. And if a start signal is received, these four counters will start counting of the output from the distinction circuit 4, and will pass signal ****** and enumerated data to an arithmetic circuit 9, and will clear enumerated data. Supposing there is an array of a printing dot as followed, for example, shown in drawing 1 (a), the distinction circuit 4 As the black dot of the column of the 1st counter of drawing 1 (c) shows to the 1st counter 5, the enumerated data in the 1st counter 5 in the period of the printing dot train which will output 1, respectively at the time of the 2nd, the 6-10th, and the 13th printing dot, therefore is shown in drawing 1 (a) are set to 7. The same is said of the 2nd counter 6 - the 4th counter 8.
[0030] A control signal is notified to an arithmetic circuit 9 from the control section which manages processing of the color picture formation which is not illustrated. There are a chrominance signal which shows of which color the process performed now is a thing, a start signal which notifies transfer initiation of a printing dot, and an end signal which notifies transfer termination of a printing dot in this control signal. Therefore, although an arithmetic circuit 9

receives enumerated data from the 1st counter 5 – the 4th counter 8, the arithmetic circuit 9 recognizes whether the enumerated data received from each counters 5–8 are the things about the image of which color with the chrominance signal from a control section.
[0031] And an arithmetic circuit 9 calculates the enumerated data of the number of an isolated dot, the enumerated data of the count of generating of 2 continuation dot, and the enumerated data of the number of a mean value dot based on carrier beam enumerated data from the 1st counter 5 – the 4th counter 8. The enumerated data of the number of an isolated dot are the enumerated data of the 3rd counter 7 itself. The enumerated data of the count of generating of 2 continuation dot are the enumerated data of the 2nd counter 6 itself. Moreover, the enumerated data of the number of a mean value dot can be calculated with the value which subtracted the enumerated data of the 1st counter 5 from the enumerated data of the 4th counter 8.
[0032] And an arithmetic circuit 9 is the weighting coefficient [as opposed to each pattern to the enumerated data of the enumerated data of the number of an isolated dot, the enumerated data of the count of generating of 2 continuation dot, and the enumerated data of the number of a mean value dot] k1, k2, and k3. Multiplication is carried out. These three values are added, the multiplication of the coefficient according to the color of a toner is further carried out to the aggregate value, the amount of offset according to the color of a toner is further added to it, and the toner consumption of the color concerned in this print is calculated. In addition, the weighting coefficient k1 to these three patterns, k2, and k3 A value, the coefficient Ky of the toner of each color, Km, Kc, and Kk The value and the amount of offset of each color are beforehand set as the arithmetic circuit 9.
[0033] The pulse modulation circuit 10 may be the thing of the hybrid configuration which generates the pulse which drives a laser beam based on a printing dot, and combined them using Pulse Amplitude Modulation using PWM.
[0034] Hereafter, although actuation is explained, the process of color picture formation shall be performed in order of C, M, Y, and K here. First, although the process of color picture formation of C is performed, a start signal is notified to the 1st counter 5 – the 4th counter 8 from a control section at this time, and the chrominance signal and start signal which show that it is color picture formation of C from a control section are notified to an arithmetic circuit 9.
[0035] And a transfer of the printing dot of the image of C is started and this printing dot is inputted into the 1st comparison circuit 2, the 2nd comparison circuit 3, and the pulse modulation circuit 10. In the pulse modulation circuit 10, pulse modulation is performed based on the value of each printing dot, and the generated pulse is supplied to a laser actuator (not shown to drawing 2).
[0036] Moreover, for the 1st comparison circuit 2, the value of the printing dot to input is the 1st threshold Vth1. The value of the printing dot which outputs the value of that printing dot to the distinction circuit 4, and inputs the 2nd comparison circuit 3 in being above is the 2nd threshold Vth2. In being above, it performs actuation which outputs the value of this printing dot to the distinction circuit 4.
[0037] And the distinction circuit 4 is based on the train of the value of the printing dot by which sequential supply is carried out from the 1st comparison circuit 2 and the 2nd comparison circuit 3. When the value of a printing dot is beyond the 1st threshold and the value of a printing dot is beyond the 2nd threshold, It is what distinguishes the case where it is four in the case of being an isolated dot when 2 continuation dot has occurred. Whenever a gradation value detects the printing dot beyond the 2nd threshold, 1 is outputted to the 1st counter 5 every. Whenever it detects that 2 continuation dot occurred, 1 is outputted to the 2nd counter 6 every, whenever it detects an isolated dot, 1 is outputted to the 3rd counter 7 every, and whenever it detects the printing dot whose gradation value is beyond the 1st threshold, actuation which outputs 1 to the 4th counter 8 every is performed.
[0038] Whenever the distinction circuits 4–1 are outputted, the 1st counter 5 – the 4th counter 8 repeat the actuation counted up every, after receiving a start signal until it receives a signal. and the 1st counter 5 – the 4th counter 8 — and — if a signal is received — the enumerated data at that time — an arithmetic circuit 9 — passing — enumerated data — clearing — the following counting — actuation is stood by.
[0039] If enumerated data are received from the 1st counter 5 – the 4th counter 8, since it recognizes that the enumerated data concerned are the enumerated data about the printing dot of the image of C, an arithmetic circuit 9 will calculate the consumption of C color toner at this time by the following formula.
C color toner consumption = Kc x{k1 x (enumerated data of the 3rd counter)
+ k2 x (enumerated data of the 2nd counter)
+ k3 x(enumerated data of the enumerated-data-1st counter of 4th counter)}
+ the amount of offset of C color toner — (5) — although the process of the image formation of M is started after doing in this way and completing the process of the image formation of C next, a start signal is notified to the 1st counter 5 – the 4th counter 8 from a control section at this time, and the chrominance signal and start signal which show that it is color picture formation of C from a control section are notified to an arithmetic circuit 9.
[0040] And a transfer of the printing dot of the image of M is started and this printing dot is inputted into the 1st comparison circuit 2, the 2nd comparison circuit 3, and the pulse modulation circuit 10. In the pulse modulation circuit 10, pulse modulation is performed based on the value of each printing dot, and the generated pulse is supplied to a laser actuator.
[0041] Moreover, for the 1st comparison circuit 2, the value of the printing dot to input is the 1st threshold Vth1. The value of the printing dot which outputs the value of that printing dot to the distinction circuit 4, and inputs the 2nd comparison circuit 3 in being above is the 2nd threshold Vth2. In being above, it performs actuation which outputs the value of this printing dot to the distinction circuit 4.
[0042] And the distinction circuit 4 is based on the train of the value of the printing dot by which sequential supply

is carried out from the 1st comparison circuit 2 and the 2nd comparison circuit 3. When the value of a printing dot is beyond the 1st threshold and the value of a printing dot is beyond the 2nd threshold, It is what distinguishes the case where it is four in the case of being an isolated dot when 2 continuation dot has occurred. Whenever a gradation value detects the printing dot beyond the 2nd threshold, 1 is outputted to the 1st counter 5 every. Whenever it detects that 2 continuation dot occurred, 1 is outputted to the 2nd counter 6 every, whenever it detects an isolated dot, 1 is outputted to the 3rd counter 7 every, and whenever it detects the printing dot whose gradation value is beyond the 1st threshold, actuation which outputs 1 to the 4th counter 8 every is performed.
[0043] Whenever the distinction circuits 4-1 are outputted, the 1st counter 5 - the 4th counter 8 repeat the actuation counted up every, after receiving a start signal until it receives a signal. and the 1st counter 5 - the 4th counter 8 — and — if a signal is received — the enumerated data at that time — an arithmetic circuit 9 — passing. — enumerated data — clearing — the following counting — actuation is stood by.
[0044] If enumerated data are received from the 1st counter 5 - the 4th counter 8, since it recognizes that the enumerated data concerned are the enumerated data about the printing dot of the image of M, an arithmetic circuit 9 will calculate the consumption of M color toner at this time by the following formula.
M color toner consumption = Km x{k1 x (enumerated data of the 3rd counter)
+ k2 x (enumerated data of the 2nd counter)
+ k3 x(enumerated data of the enumerated-data-1st counter of 4th counter)}
+ The amount of offset of M color toner — (6) [0045] Next, although the process of the image formation of Y is performed, and the process of the image formation of K is performed continuously, the toner consumption of Y color and the toner consumption of K color are calculated similarly also at the time of these image formation processes. The consumption of Y color toner at this time and the consumption of K color toner are as follows respectively.
[0046]
Y color toner consumption = Ky x{k1 x (enumerated data of the 3rd counter)
+ k2 x (enumerated data of the 2nd counter)
+ k3 x(enumerated data of the enumerated-data-1st counter of 4th counter)}
+ The amount of offset of Y color toner — (7) K color toner consumption = Kk x{k1 x (enumerated data of the 3rd counter)
+ k2 x (enumerated data of the 2nd counter)
+ k3 x(enumerated data of the enumerated-data-1st counter of 4th counter)}
+ The amount of offset of K color toner — (8) [0047] In addition, although the operation of the toner consumption of each color is performed for every formation process of one color image in the above example since the case where the electrostatic latent image of four colors of C, M, Y, and K was applied to the color laser beam printer of the type formed in one photo conductor by one laser beam was explained In applying to the so-called tandem type equipped with four sets of a photo conductor and a development counter of thing Although it is also possible to calculate toner consumption per one print, of course since what is necessary is just to form this toner consumption detection equipment in the system of four image formation processes, C, M, Y, and K, respectively It is also possible to calculate toner consumption in an unit with proper job unit or one-day unit etc. In that case, naturally it is necessary to change suitably the gestalt of the control signal notified to four counters and an arithmetic circuit 9 according to the unit which calculates toner consumption.
[0048] The weighting coefficient [as opposed to three patterns by the above-mentioned explanation] k1, k2, and k3 Although the value shall use the same value, since a property changes with colors of a toner, the weighting coefficient to the pattern of an isolated dot, the weighting coefficient to the pattern of 2 continuation dot, and the weighting coefficient to the pattern of a mean value dot may be changed by the color of a toner.
[0049] What is necessary is just to give the data of the consumption of the toner of each color for which it asked in the arithmetic circuit 9 to a means to manage the processing which performs the display of toner consumption or a toner residue. In the printing screen of the personal computer which gives by this the image data printed on the color laser beam printer concerned, if it has the proper display function to the printer concerned itself possible [displaying the consumption or the residue of a toner of each color with proper graphs, such as a bar graph], it is possible to display the consumption or the residue of a toner of each color using the display function.
[0050] Since it is above, according to this toner consumption detection equipment, the toner consumption of each color can be calculated with an easy configuration, and it is possible to apply to the thing using any pulse modulation methods moreover.
[0051] The [2nd toner consumption detection method], next the 2nd amount detection method of toners are explained. In addition, about an isolated dot, 2 continuation dot, a mean value dot, the 1st threshold, and the 2nd threshold, it is the same in having mentioned above.
[0052] This 2nd method is amelioration of the 1st method mentioned above. By the 1st method, the pattern of the array of a printing dot train Although it classified into three kinds, an isolated dot, 2 continuation dot, and a mean value dot, and the consumption of the toner of each color was detected based on three enumerated data, the enumerated data of the number of an isolated dot, the enumerated data of the count of generating of 2 continuation dot, and the enumerated data of the number of a mean value dot He is trying to also distinguish 3 continuation dot by this 2nd method in addition to three kinds of above-mentioned patterns. Here, 3 continuation dot shall mean the case where three printing dots whose gradation values are beyond the 2nd threshold continue.
[0053] To 2 continuation dot, in addition, also distinguishing 3 continuation dot By for example, three cases where two printing dots of the maximum gradation are continuing and the case where it is continuing Since the latter toner

consumption has the phenomenon of increasing more than it instead of 3/2 of the former toner consumption a little, it is because it is thought that toner consumption can be detected with a more sufficient precision by distinguishing 2 continuation dot and 3 continuation dot.
[0054] Specifically, it is as follows. Now, the toner consumption of each color shall be detected per 1 page. Moreover, the process of color picture formation shall be performed in order of C, M, Y, and K.
[0055] In this case, counting of the number of an isolated dot, the count of generating of 2 continuation dot, the count of generating of 3 continuation dot, and the number of a mean value dot is first carried out about the printing dot of the image of C color which carries out a sequential input. For example, it carries out to it seeming that the printing dot train of the image of C color shows now drawing 3 (a). In addition, drawing 3 (a) is the same as drawing 1 (a). 1 printing dots are 6 bit patterns, and are taken as the 1st threshold Vth 1= 1 and the 2nd threshold Vth 2= 48 also here.
[0056] About an isolated dot, 2 continuation dot, and a mean value dot, it is the same in having explained by the 1st method. About 3 continuation dot, it is as follows. The gradation value of the 6th printing dot is beyond the 2nd threshold, and both the gradation values of the 7th and the 8th following printing dot are also beyond the 2nd threshold. Therefore, since the printing dot beyond the 2nd threshold is following [the gradation value] the 6th, the 7th, and the 8th, 3 continuation dot has occurred once here. It shows this that the black dot is attached to the part of the 8th printing dot of the column of 3 continuation dot of drawing 3 (b). Similarly, since each gradation value of the 7th, the 8th, and the 9th printing dot is beyond the 2nd threshold, 3 continuation dot has occurred once also here. It shows this that the black dot is attached to the part of the 9th printing dot of the column of 3 continuation dot of drawing 3 (b). It is the same as that of the following. Therefore, in the case of drawing 3 (a), the enumerated data of the number of 3 and a mean value dot are set [the enumerated data of the number of an isolated dot / the enumerated data of the count of generating of 2 and 2 continuation dot] to 6 by the enumerated data of the count of generating of 4 and 3 continuation dot.
[0057] And the multiplication of the weighting coefficient to each pattern is carried out to these four enumerated data, respectively, and those four values are added. And the multiplication of the coefficient of the toner of C color is further carried out to the aggregate value, the amount of offset is further applied to the multiplication value, and the amount of toners of C color then consumed is calculated. Therefore, the consumption of 1 concerned page C color toner A weighting coefficient [as opposed to the pattern of k1 and 2 continuation dot for the weighting coefficient to the pattern of an isolated dot] k2, It is a weighting coefficient [as opposed to the pattern of k3 and a mean value dot for the weighting coefficient to the pattern of 3 continuation dot] k4 It carries out and is Kc about the coefficient of the toner of C color. It carries out. C color toner consumption = Kc x{k1 x (enumerated data of the number of an isolated dot)
+ k2 x (enumerated data of the count of generating of 2 continuation dot)
+ k3 x (enumerated data of the count of generating of 3 continuation dot)
+ k4 x(enumerated data of the number of mean value dot)}
+ The amount of offset of C color toner — It is set to (9).
[0058] Next, although the sequential input of the printing dot of the image of M color is carried out, counting of the number of an isolated dot, the count of generating of 2 continuation dot, the count of generating of 3 continuation dot, and the number of a mean value dot is similarly carried out to the printing dot of the image of M color. And the multiplication of the weighting coefficient to each pattern is carried out to these four enumerated data, respectively, and those four values are added. and — further — the aggregate value — the coefficient of the toner of M color — multiplication — carrying out — further — the multiplication value — the amount of offset — in addition, the amount of toners of M color then consumed is calculated. Therefore, the consumption of 1 concerned page C color toner is Km about the coefficient of the toner of M color. It carries out. M color toner consumption = Km x{k1 x (enumerated data of the number of an isolated dot)
+ k2 x (enumerated data of the count of generating of 2 continuation dot)
+ k3 x (enumerated data of the count of generating of 3 continuation dot)
+ k4 x(enumerated data of the number of mean value dot)}
+ The amount of offset of M color toner — It is set to (10).
[0059] The same is said of the printing dot of the image of following and Y color, and the printing dot of the image of K color. Therefore, the consumption of 1 concerned page Y color toner and the consumption of K color toner are Kk about the coefficient of the toner of Ky and K color in the coefficient of the toner of Y color. It carries out and is each. Y color toner consumption = Ky x{k1 x (enumerated data of the number of an isolated dot)
+ k2 x (enumerated data of the count of generating of 2 continuation dot)
+ k3 x (enumerated data of the count of generating of 3 continuation dot)
+ k4 x(enumerated data of the number of mean value dot)}
+ The amount of offset of Y color toner — (11) K color toner consumption = Kk x{k1 x (enumerated data of the number of an isolated dot)
+ k2 x (enumerated data of the count of generating of 2 continuation dot)
+ k3 x (enumerated data of the count of generating of 3 continuation dot)
+ k4 x(enumerated data of the number of mean value dot)}
+ The amount of offset of K color toner — It is set to (12).
[0060] In addition, the weighting coefficient k1 to each above-mentioned pattern, k2, k3, and k4 And the coefficient Ky of the toner of each color, Km, Kc, and Kk A value The amount of toners of each color which printed about

various images and was then printed by the record form is surveyed. The surveyed amount of toners, What is necessary is just to set based on the relation between the number of the isolated dot of the printing dot train of each color of the image printed at that time, the count which 2 continuation dot generates, the count which 3 continuation dot generates, and the number of a mean value dot etc.

[0061] The weighting coefficient [as opposed to four patterns at the above-mentioned (9) - (12) type] k1, k2, and k3 and k4 Although the value shall use the same value A weighting coefficient [as opposed to the pattern of an isolated dot by the color of a toner] since a property changes with colors of a toner, The weighting coefficient to the pattern of 2 continuation dot, the weighting coefficient to the pattern of 3 continuation dot, and the weighting coefficient to the pattern of a mean value dot may be changed. Moreover, in the above-mentioned explanation, although the 2nd threshold made all the same about C, M, Y, and K, it may be changed by the color. in addition, as for various consumption of the toner of each color for which carried out in this way and it asked, it is same in having mentioned above that it can be alike and can use.

[0062] Since it is above, by this toner consumption detection method The pattern of the printing dot train of each color of a printing image An isolated dot, 2 continuation dot, It divides into four kinds of 3 continuation dot and a mean value dot. The number of an isolated dot, Counting of the count of generating of 2 continuation dot, the count of generating of 3 continuation dot, and the number of a mean value dot is carried out. Since what is necessary is just to perform processing in which carry out the multiplication of the weighting coefficient to each pattern to these four enumerated data, and add it to them, and carry out the multiplication of the coefficient according to the color of a toner to the aggregate value, and the amount of offset is added to the multiplication value, it is realizable with an easy configuration so that it may mention later. Moreover, since this toner consumption detection method detects toner consumption based on a printing dot train, it is not based on the pulse modulation method which generates the pulse for driving a laser beam, but can be applied also to the equipment which uses a Pulse-Amplitude-Modulation (Pulse Amplitude Modulation) method also for the equipment using PWM, or the equipment of the hybrid configuration which combined PWM and Pulse Amplitude Modulation.

[0063] One operation gestalt of [the toner consumption detection equipment which adopted the 2nd toner consumption detection method], next the toner consumption detection equipment which detects toner consumption by the 2nd toner consumption detection method mentioned above is explained. In addition, 1 printing dot presupposes that they are 6 bit patterns here.

[0064] Drawing 4 is drawing showing the partial block diagram of 1 operation gestalt at the time of applying toner consumption detection equipment to a color laser beam printer. Although the configuration shown in drawing 4 is the same as that of what is shown in drawing 2 , a part of the actuation differs. In drawing 4 , in 11, a dot array pattern distinction circuit (a distinction circuit is only called hereafter) and 13 show the 2nd counter, and, as for toner consumption detection equipment and 12, 14 shows an arithmetic circuit. In addition, in drawing 4 , the explanation which attaches the same sign and overlaps about the same thing as what is shown in drawing 2 will be minimized. Moreover, although [here / a color laser beam printer] it is the thing of the type with which the development counter of four colors of C, M, Y, and K has been arranged around one photo conductor, the configuration of this type of the whole color laser beam printer is common knowledge, and since it moreover is not the essence of this invention, by drawing 4 , the graphic display is omitted about the photo conductor or the development counter.

[0065] The distinction circuit 12 is based on the train of the value of the printing dot by which a sequential input is carried out from the 1st comparison circuit 2 and the 2nd comparison circuit 3. When the value of a printing dot is beyond the 1st threshold and the value of a printing dot is beyond the 2nd threshold, It is what distinguishes the case where it is four in the case of being an isolated dot when 3 continuation dot has occurred. Whenever a gradation value detects the printing dot beyond the 2nd threshold, 1 is outputted to the 1st counter 5 every. Whenever it detects that 3 continuation dot occurred, 1 is outputted to the 2nd counter 13 every, whenever it detects an isolated dot, 1 is outputted to the 3rd counter 7 every, and whenever it detects the printing dot whose gradation value is beyond the 1st threshold, 1 is outputted to the 4th counter 8 every.

[0066] The 1st counter 5, the 2nd counter 13, the 3rd counter 7, and the 4th counter 8 will perform actuation which counts up only 1, respectively, if the distinction circuits 12-1 are outputted. In addition, a control signal is notified to these four counters from the control section which manages processing of the color picture formation which is not illustrated, respectively. There are a start signal which notifies transfer initiation of a printing dot, and an end signal which notifies transfer termination of a printing dot in this control signal. And if a start signal is received, these four counters will start counting of the output from the distinction circuit 12, and will pass signal ****** and enumerated data to an arithmetic circuit 14, and will clear enumerated data. Supposing there is an array of a printing dot as followed, for example, shown in drawing 3 (a), the distinction circuit 12 As the black dot of the column of the 1st counter of drawing 1 (c) shows to the 1st counter 5, the enumerated data in the 1st counter 5 in the period of the printing dot train which will output 1, respectively at the time of the 2nd, the 6-10th, and the 13th printing dot, therefore is shown in drawing 1 (a) are set to 7. The same is said of the 2nd counter 13, the 3rd counter 7, and the 4th counter 8.

[0067] A control signal is notified to an arithmetic circuit 14 from the control section which manages processing of the color picture formation which is not illustrated. There are a chrominance signal which shows of which color the process performed now is a thing, a start signal which notifies transfer initiation of a printing dot, and an end signal which notifies transfer termination of a printing dot in this control signal. Therefore, although an arithmetic circuit 14 receives enumerated data from the 1st - the 4th counter, the arithmetic circuit 14 recognizes whether the enumerated data received from each counter are the things about the image of which color with the chrominance

signal from a control section.
[0068] And an arithmetic circuit 14 calculates the enumerated data of the number of an isolated dot, the enumerated data of the count of generating of 2 continuation dot, the enumerated data of the count of generating of 3 continuation dot, and the enumerated data of the number of a mean value dot based on carrier beam enumerated data from the 1st counter - the 4th counter. The enumerated data of the number of an isolated dot are the enumerated data of the 3rd counter 7 itself. The enumerated data of the count of generating of 3 continuation dot are the enumerated data of the 2nd counter 13 itself. Moreover, the enumerated data of the count of generating of 2 continuation dot can be calculated with the value which subtracted the enumerated data of the 2nd counter, and the enumerated data of the 3rd counter from the enumerated data of the 1st counter 5. Furthermore, the enumerated data of the number of a mean value dot can be calculated with the value which subtracted the enumerated data of the 1st counter 5 from the enumerated data of the 4th counter 8.
[0069] An arithmetic circuit 14 And enumerated data of the number of an isolated dot, enumerated data of the count of generating of 2 continuation dot, The weighting coefficient [respectively as opposed to each pattern to four enumerated data of the enumerated data of the count of generating of 3 continuation dot, and the enumerated data of the number of a mean value dot] k1, k2, k3, and k4 Multiplication is carried out. These four values are added, the multiplication of the coefficient according to the color of a toner is further carried out to the aggregate value, the amount of offset according to the color of a toner is further added to it, and the toner consumption of the color concerned in this print is calculated. In addition, the weighting coefficient k1 to these four patterns, k2, k3, and k4 A value, the coefficient Ky of the toner of each color, Km, Kc, and Kk The value and the amount of offset of each color are beforehand set as the arithmetic circuit 14.
[0070] Hereafter, although actuation is explained, the process of color picture formation shall be performed in order of C, M, Y, and K here. First, although the process of color picture formation of C is performed, a start signal is notified to the 1st counter 5 - the 4th counter 8 from a control section at this time, and the chrominance signal and start signal which show that it is color picture formation of C from a control section are notified to an arithmetic circuit 14.
[0071] And a transfer of the printing dot of the image of C is started and this printing dot is inputted into the 1st comparison circuit 2, the 2nd comparison circuit 3, and the pulse modulation circuit 10. In the pulse modulation circuit 10, pulse modulation is performed based on the value of each printing dot, and the generated pulse is supplied to a laser actuator (not shown to drawing 4).
[0072] Moreover, for the 1st comparison circuit 2, the value of the printing dot to input is the 1st threshold Vth1. The value of the printing dot which outputs the value of that printing dot to the distinction circuit 12, and inputs the 2nd comparison circuit 3 in being above is the 2nd threshold Vth2. In being above, it performs actuation which outputs the value of this printing dot to the distinction circuit 12.
[0073] And the distinction circuit 12 is based on the train of the value of the printing dot by which sequential supply is carried out from the 1st comparison circuit 2 and the 2nd comparison circuit 3. When the value of a printing dot is beyond the 1st threshold and the value of a printing dot is beyond the 2nd threshold, It is what distinguishes the case where it is four in the case of being an isolated dot when 3 continuation dot has occurred. Whenever a gradation value detects the printing dot beyond the 2nd threshold, 1 is outputted to the 1st counter 5 every. Whenever it detects that 3 continuation dot occurred, 1 is outputted to the 2nd counter 13 every, whenever it detects an isolated dot, 1 is outputted to the 3rd counter 7 every, and whenever it detects the printing dot whose gradation value is beyond the 1st threshold, actuation which outputs 1 to the 4th counter 8 every is performed.
[0074] Whenever the distinction circuits 12-1 are outputted, the 1st counter 5 - the 4th counter 8 repeat the actuation counted up every, after receiving a start signal until it receives a signal. and the 1st counter 5 - the 4th counter 8 — and — if a signal is received — the enumerated data at that time — an arithmetic circuit 14 — passing — enumerated data -- clearing -- the following counting — actuation is stood by.
[0075] If enumerated data are received from the 1st counter 5 - the 4th counter 8, an arithmetic circuit 14 Since it recognizes that the enumerated data concerned are the enumerated data about the printing dot of the image of C They are [enumerated data / of the 1st counter 5] the enumerated data of c3 and the 4th counter 8 about the enumerated data of c2 and the 3rd counter 7 in the enumerated data of c1 and the 2nd counter 13 c4 It carries out and the consumption of C color toner at this time is calculated by the following formula.
C color toner consumption =Kcx{k1xc3+k2x(c1-c2-c3)+k3xc2 + The amount of offset of a k4x(c4-c1)}+C color toner — (13) Here k1 The weighting coefficient and k2 to the pattern of an isolated dot The weighting coefficient and k3 to the pattern of 2 continuation dot The weighting coefficient and k4 to the pattern of 3 continuation dot It is a weighting coefficient to the pattern of a mean value dot.
[0076] Thus, although image formation of M is performed, the process of the image formation of Y is performed to the degree and the process of the image formation of K is further performed to it after the process of the image formation of C is completed next, an arithmetic circuit 14 calculates the toner consumption of M color, the toner consumption of Y color, and the toner consumption of K color by the following formula similarly also at the time of these image formation processes.
[0077]
M color toner consumption =Kmx{k1xc3+k2x(c1-c2-c3)+k3xc2 + The amount of offset of a k4x(c4-c1)}+M color toner — (14) Y color toner consumption =Kyx{k1xc3+k2x(c1-c2-c3)+k3xc2 + The amount of offset of a k4x(c4-c1)} +Y color toner — (15) K color toner consumption =Kkx{k1xc3+k2x(c1-c2-c3)+k3xc2 The amount of offset of a +k4x (c4-c1)}+K color toner — (16) [0078] The weighting coefficient [as opposed to / as mentioned above / four

patterns] k1, k2, k3, and k4 A value and the coefficient Ky of the toner of each color, Km, Kc, and Kk Although a value can be calculated by experiment When 1 printing dot considers as 6 bit patterns and the 2nd threshold Vth 2= 48 according to the experiment of this invention person, k1 =0.76 — (17) k2 =1.00 — (18) k3 =1.10 — (19) k4 =0.30 — (20) Kc =9.20x10-6 — (21) Km =10.50x10-6 — (22) Ky =9.95x10-6 — (23) Kk =12.53x10-6 — (24) was obtained. When calculating (13) - (16) type using these values, it was checked that the toner consumption of each color can be calculated in the unit of mg.

[0079] In addition, although the operation of the toner consumption of each color is performed for every formation process of one color image in the above example since the case where the electrostatic latent image of four colors of C, M, Y, and K was applied to the color laser beam printer of the type formed in one photo conductor by one laser beam was explained In applying to the so-called tandem type equipped with four sets of a photo conductor and a development counter of thing Although it is also possible to calculate toner consumption per one print, of course since what is necessary is just to form this toner consumption detection equipment in the system of four image formation processes, C, M, Y, and K, respectively It is also possible to calculate toner consumption in an unit with proper job unit or one-day unit etc. In that case, naturally it is necessary to change suitably the gestalt of the control signal notified to four counters and an arithmetic circuit 14 according to the unit which calculates toner consumption.

[0080] In addition, the weighting coefficient [as opposed to four patterns by the above-mentioned explanation] k1, k2, and k3 and k4 Although the value shall use the same value A weighting coefficient [as opposed to the pattern of an isolated dot by the color of a toner] since a property changes with colors of a toner, The weighting coefficient to the pattern of 2 continuation dot, the weighting coefficient to the pattern of 3 continuation dot, and the weighting coefficient to the pattern of a mean value dot may be changed.

[0081] About the method of utilization of the data of the consumption of the toner of each color for which it asked in the arithmetic circuit 14, it is the same in having mentioned above.

[0082] Since it is above, according to this toner consumption detection equipment, the toner consumption of each color can be calculated with an easy configuration, and it is possible to apply to the thing using any pulse modulation methods moreover.

[0083] A [experimental result], next the experimental result which this invention person performed are shown in drawing 5 . Drawing 5 is drawing showing the relation between the theoretical value of the toner consumption per sheet when printing 19 various images, such as an image containing both the graphic image and natural image containing many natural images, such as a landscape, geometric figures, etc., and a graphic image, and the actual measurement of the amount of toners actually consumed at the time of a print. In addition, in this experiment, 1 printing dots are 6 bit patterns, and are the 1st threshold Vth 1= 1 and the 2nd threshold Vth 2= 48.

[0084] Here, the theoretical value of toner consumption is the consumption of the toner of each color for which it asked by (13) - (16) type using the value of above-mentioned (17) - (24). The consumption of M toner and drawing 5 (c) show the consumption of C color toner, drawing 5 (d) shows the consumption of K color toner, a horizontal axis is a theoretical value per sheet, the axis of ordinate of all is an actual measurement per sheet, and the consumption of Y color toner and drawing 5 (b) are [units of drawing 5 (a)] mg(s). Moreover, every point of the image with which each which is plotted at the white round head or black rectangular head of drawing 5 (a) - (d) printed, respectively is shown, and 19 points are plotted by each of drawing 5 (a) - (d). Moreover, although the equation "y=1.0000x-0.0002" is indicated by drawing 5 (a), this is a linear equation shown in drawing 5 (a) when a horizontal axis is set to x and it sets an axis of ordinate to y. Moreover, although the publication "R2 =0.9831" is shown in drawing 5 (a), this is a correlation coefficient when searching for the correlation of a theoretical value and an actual measurement about 19 points currently plotted. Drawing 5 (b) The same is said of - (d).

[0085] Then, if drawing 5 (a) - (d) is seen, as for the correlation coefficient of a theoretical value and an actual measurement, it turns out about the toner of all colors that near and the point currently plotted are good on one straight line, and it has ridden 1. it is shown that this, i.e., a theoretical value, suits the actual measurement well — **** — it does not become others.

[0086] Next, drawing 6 is shown for drawing 5 and a comparison. Drawing 6 is drawing showing the relation between the theoretical value of the toner consumption when printing the 19 same images, and the actual measurement of the amount of toners actually consumed at the time of a print with having printed by drawing 5 . Although it is ** and the 1st threshold Vth 1= 1 in 1 printing dot ** h6 bit pattern also in this experiment, it is made with the 2nd threshold Vth 2= 63. That is, in this experiment, the 2nd threshold is made with the maximum gradation value. In addition, the semantics of an equation and the semantics of a correlation coefficient are the same as drawing 5 .

[0087] Drawing 6 (a) When - (d) is seen, it turns out that there is a plot which is separated from the straight line, and that it is worse than what a correlation coefficient shows to drawing 5 . The above thing shows that it is useful to set the 2nd threshold to 48 with a gradation value, when 1 printing dots are 6 bit patterns.

[0088] thus, the case where 1 printing dots are 6 bit patterns — the 2nd threshold Vth2 although the theoretical explanation about what it can be referred to as 48 with a gradation value, the pattern of a printing dot train can be divided into four patterns, an isolated dot, 2 continuation dot, 3 continuation dot, and a mean value dot, and (9) - (12) type can detect toner consumption with a sufficient precision for is dramatically difficult — an outline — it is thought that the following can be said.

[0089] When 1 printing dots are 6 bit patterns, as are mentioned above, and a gradation value shows 48 by P in drawing 7 , supporting the gradation value near [with the longer laser luminescence time amount in the graph which shows the relation between laser luminescence time amount and toner consumption] the point of inflection is

checked. And when it is going to set up a threshold, adopting the point of inflection of a graph or the value of the near generally in many cases is known well. Moreover, the printing dot of the gradation value of P or more points can be considered that the amount of toners consumed is equivalent so that clearly also from the property of the continuous line of drawing 7 . From the above thing, when 1 printing dots are 6 bit patterns, it is considered that there is validity to set the 2nd threshold to 48 with a gradation value.

[0090] However, it is desirable to distinguish the case of an isolated dot, the case of 2 continuation dot, and the case of 3 continuation dot for the reason mentioned above, even if a value is a printing dot beyond the 2nd threshold. From this, there is validity of a value dividing into three patterns, an isolated dot, 2 continuation dot, and 3 continuation dot, about the printing dot beyond the 2nd threshold.

[0091] As mentioned above, from the property of the continuous line of drawing 7 , although it is possible that the amount of toners in which a value is consumed about the printing dot beyond the 2nd threshold is equivalent, since it cannot say, that a value is such about the printing dot of under the 2nd threshold must carry out another handling. This is a mean value dot.

[0092] By the way, although what is shown with the dashed line of drawing 7 connects the ends of the property shown as a continuous line and it is the case where the property of laser luminescence time amount and toner consumption is linearity, the toner consumption of a mean value dot with a small value is smaller than the case of a linearity property, and the toner consumption of a mean value dot with a large value will become [many] from the case of a linearity property. If the average of the value of a mean value dot is taken when are seen about the value of each printing dot from this and many printing dots are seen as a whole like an one image unit although the value of a printing dot and the relation of toner consumption are nonlinear to be sure, it will be expected whether the average is settled in a certain specific value. Then, the printing dot which a value is beyond the 1st threshold and is under the 2nd threshold is considered that there is validity of treating in all together as a mean value dot.

[0093] As mentioned above, when 1 printing dots are 6 bit patterns, this invention person from the above thing as the 1st threshold Vth 1= 1 and the 2nd threshold Vth 2= 48 A printing dot train to four kinds, an isolated dot, 2 continuation dot, 3 continuation dot, and a mean value dot, a pattern part opium poppy. The number of an isolated dot, the count of generating of 2 continuation dot, the count of generating of 3 continuation dot, When counting of the number of an isolated dot tended to be carried out, (9) - (12) type tended to detect the toner consumption of each color based on those enumerated data and it asked for the weighting coefficient to each pattern, and the coefficient of the toner of each color by experiment, the result as shown in drawing 5 was obtained.

[0094] Since it is above, according to this toner consumption detection equipment, the consumption of the toner of each color can be calculated with a sufficient precision with an easy configuration, and, moreover, it can apply also to the equipment using the thing of a hybrid configuration, or the equipment which performs pulse modulation by other methods also at the equipment which uses Pulse Amplitude Modulation also for equipment using PWM as a pulse modulation method.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

TECHNICAL FIELD

[A technical field to which invention belongs] This invention relates to a method and equipment which calculate consumption of a toner of each color with a sufficient precision with an easy configuration in color picture formation equipments, such as a color laser beam printer which forms an electrostatic latent image in a photo conductor by light beam modulated with print data, and a color toner which is a record material is made to stick to this electrostatic latent image electrostatic, and forms an image in a record form.

[Translation done.]

TECHNICAL PROBLEM

[Description of the Prior Art] In the equipment which performs color picture formation using color toners, such as a color laser beam printer, it is requested to the user that the consumption or the residue of a toner of yellow (Y), a Magenta (M), cyanogen (C), and black (K) is shown. [of each color] For that purpose, although the toner of each color needs to detect which was consumed every whenever it performs color picture formation In color picture formation equipment in recent years, many gradation, i.e., 1 printing dot, is made for each dot (this is called a printing dot) actually printed by the record form with two or more bit configuration. Moreover, the value of a printing dot, Since the relation with the amount of toners consumed is nonlinear, it is made very difficult to detect the toner consumption of each color of C, M, Y, and K which are consumed when color picture formation is performed.
[0003] Although it is known well that the value of a printing dot and the relation of toner consumption are nonlinear, the following occurs, for example. Although it is common that the Pulse-Density-Modulation (PWM) method which generates the pulse which has the width of face according to the value of a printing dot as a pulse modulation method, and controls the luminescence time amount of a laser beam by current color picture formation equipment is adopted It is known that the relation between the width of face of the pulse outputted from the laser luminescence time amount, i.e., PWM circuit, when printing only the printing dot of a piece and the amount of toners consumed by the printed dot comes to be shown as the continuous line of a schematic diagram 7 . Since laser luminescence time amount responds to the value of a printing dot, it can be said that the above thing means that the relation between the value of a printing dot and toner consumption is nonlinear.
[0004] However, the relation shown as the continuous line of drawing 7 always is not realized. For example, though the toner consumption when printing only one printing dot of a certain value independently is Xmg, the amount of toners required for printing the printing dot concerned depending on the value of the printing dot adjoined before and behind the printing dot concerned differs from Xmg. Thus, also when printing only one printing dot independently, the value of a printing dot and the relation of the amount of consumption toners are nonlinear, and the amount of toners consumed when printing the printing dot concerned further also with the value of the printing dot adjoined before and behind that has a very complicated phenomenon [say / change].
[0005] This invention was made in view of the above situations, and also in the color picture formation equipment whose 1 printing dot is two or more bit configuration, it is an easy configuration and it aims at offering the toner consumption detection method and equipment which it is moreover accurate and can detect the consumption of the toner of each color of C, M, Y, and K.

[Translation done.]

MEANS

[Means for Solving the Problem] In order to attain the above-mentioned object, the 1st toner consumption detection method concerning this invention About an image of each color printed like at a period of a predetermined unit according to claim 1 A printing dot train is divided into three patterns, an isolated dot, 2 continuation dot, and a mean value dot, counting of the number of an isolated dot, a count of generating of 2 continuation dot, and the number of a mean value dot is carried out, and it is characterized by calculating consumption of a toner of each color recorded on a record form based on those enumerated data. Moreover, the 2nd toner consumption detection method concerning this invention About an image of each color printed like at a period of a predetermined unit according to claim 2 A printing dot train is divided into four patterns, an isolated dot, 2 continuation dot, 3 continuation dot, and a mean value dot. Counting of the number of an isolated dot, a count of generating of 2 continuation dot, a count of generating of 3 continuation dot, and the number of a mean value dot is carried out, and it is characterized by calculating consumption of a toner of each color recorded on a record form based on those enumerated data. The 1st toner consumption detection equipment concerning this invention The 1st comparison circuit according to claim 3 which compares the 1st threshold with a value of a printing dot like, The 2nd comparison circuit which compares the 2nd larger threshold than the 1st threshold with a value of a printing dot, It is based on an output of the 1st comparison circuit and the 2nd comparison circuit. A printing dot train An isolated dot, It divides into three patterns of 2 continuation dot and a mean value dot, counting of the number of an isolated dot, a count of generating of 2 continuation dot, and the number of a mean value dot is carried out, and it is characterized by having an operation means to calculate consumption of a toner of each color recorded on a record form based on those enumerated data. Moreover, the 2nd toner consumption detection equipment concerning this invention The 1st comparison circuit according to claim 4 which compares the 1st threshold with a value of a printing dot like, The 2nd comparison circuit which compares the 2nd larger threshold than the 1st threshold with a value of a printing dot, It is based on an output of the 1st comparison circuit and the 2nd comparison circuit. A printing dot train An isolated dot, It divides into three patterns, 2 continuation dot, 3 continuation dot, and a mean value dot. Counting of the number of an isolated dot, a count of generating of 2 continuation dot, a count of generating of 3 continuation dot, and the number of a mean value dot is carried out, and it is characterized by having an operation means to calculate consumption of a toner of each color recorded on a record form based on those enumerated data.
[0007]
[Embodiment of the Invention] Hereafter, the gestalt of implementation of invention is explained, referring to a drawing. By the way, since the relation between the value of a printing dot and the amount of consumption toners is nonlinear as mentioned above, it will become difficult for it to detect toner consumption paying attention to the value of a printing dot. Then, this invention person found out two methods of the printing dot train to input being the array of the printing dot of what kind of value without paying attention to value itself of each printing dot, or detecting toner consumption paying attention to the pattern of the array as a result of various experiments. The 1st method is a fundamental method and the 2nd method is amelioration of the 1st method. In addition, an experimental result is shown later.
[0008] [the 1st toner consumption detection method] — the 1st method is explained first. It sets to this method and they are two thresholds Vth1 and Vth2 to the value of a printing dot. It sets and the pattern division of the array pattern of a printing dot train is carried out at three kinds. The 1st threshold Vth1 It is for distinguishing and sets to Vth 1= 1 whether to be that to which a printing dot consumes a toner with the gradation value of a printing dot. The 2nd threshold Vth2 Although it is for distinguishing whether a gradation value is above to some extent and can set suitably by the bit pattern of a printing dot, when 1 printing dots are 6 bit patterns, it is checked by experiment that it is good to be referred to as about 2= 48 Vth with the gradation value of a printing dot. About this, the example of a comparison is shown later. In fact, when 1 printing dots are 6 bit patterns, as P shows Vth 2= 48 in drawing 7 , supporting the gradation value near [with the longer laser luminescence time amount in the graph which shows the relation between laser luminescence time amount and toner consumption] the point of inflection is checked.
[0009] And the pattern division of the pattern of the array of a printing dot train is carried out at the following three kinds.
** Isolated dot — Printing dot both whose gradation values of the printing dot before and behind that it is the printing dot whose gradation value is beyond the 2nd threshold, and are under the 2nd threshold. Such a printing dot is called an isolated dot.
** 2 continuation dot — When two printing dots whose gradation values are beyond the 2nd threshold continue.

This case is called 2 continuation dot.
** Mean value dot — Printing dot whose gradation value is under the 2nd threshold above the 1st threshold. Such a printing dot is defined as a mean value dot.
[0010] thus, carrying out a pattern division — an outline — it is as follows. The printing dot whose value is beyond the 2nd threshold differs in toner consumption clearly from a mean value dot so that he can understand easily also from drawing 7 . Then, the validity of a value dividing into the thing beyond the 2nd threshold and the mean value dot below it first is clear. Next, about distinguishing an isolated dot and 2 continuation dot, it is as follows. For example, suppose that it turns out about a certain color that the toner consumption when printing only one printing dot of the maximum gradation independently is Xmg. Supposing it prints 2 dots of printing dots of the maximum gradation continuously at this time, it is known that the consumption of the toner of the color concerned at this time will increase more than that instead of twice of Xmg a little. According to such a situation, even if a value is a printing dot beyond the 2nd threshold, the pattern division of the case where two cases where it is isolated are followed is carried out.
[0011] And C of the image printed at the period of an unit with proper 1-page unit or job unit etc., For every image of each color of M, Y, and K, carry out counting of the number of an isolated dot, the count of generating of 2 continuation dot, and the number of a mean value dot, and each of the three enumerated data is received. Carry out the multiplication of the coefficient of weighting to each pattern, and these three values are added. By carrying out the multiplication of the coefficient according to the color of a toner to the aggregate value, the consumption of the toner of each color recorded on the record form is calculated, the amount of offset is applied to it and the total amount of toners of each color then consumed is calculated.
[0012] Here, the amount of offset is the amount of toners consumed regardless of the exposure time by the laser beam, and it is characteristic characteristic value for every color picture formation equipment. That is, if a photo conductor is cleaned also when a pure white image is printed, it is known that some toners will be discharged. This is the amount of offset. Since this amount of offset changes with colors, the amount of offset is measured about the toner of each color of C, M, Y, and K, respectively.
[0013] Specifically, it is as follows. Now, the toner consumption of each color shall be detected per 1 page. Moreover, the process of color picture formation shall be performed in order of C, M, Y, and K.
[0014] In this case, counting of the number of an isolated dot, the count of generating of 2 continuation dot, and the number of a mean value dot is first carried out about the printing dot of the image of C color which carries out a sequential input. For example, it carries out to it seeming that the printing dot train of the image of C color shows now drawing 1 (a). In drawing 1 (a), 1 printing dot presupposes that it is 64 gradation in 6 bit patterns, and is taken as the 1st threshold Vth 1= 1 and the 2nd threshold Vth 2= 48. And a rectangle shows each printing dot and the numeric value in a rectangle shows the gradation value of each printing dot. Moreover, in drawing 1 (a), the number of 1-14 is attached to the printing dot for convenience.
[0015] Now, in drawing 1 (a), since it is beyond the 2nd threshold since the gradation value of the 2nd printing dot is 60, and both the gradation values of the printing dot before and behind that are under the 2nd threshold in 40 and 20, the 2nd printing dot is an isolated dot. The 13th printing dot is an isolated dot similarly. The black dot of the column of the isolated dot of drawing 1 (b) shows this.
[0016] Moreover, the gradation value of the 6th printing dot is beyond the 2nd threshold, and the gradation value of the 7th following printing dot is also beyond the 2nd threshold. Therefore, since the printing dot beyond the 2nd threshold is following [the gradation value] the 6th and the 7th, 2 continuation dot has occurred once here. It shows this that the black dot is attached to the part of the 7th printing dot of the column of 2 continuation dot of drawing 1 (b). Similarly, since both the gradation values of the 7th and the 8th printing dot are beyond the 2nd threshold, 2 continuation dot has occurred once also here. It shows this that the black dot is attached to the part of the 8th printing dot of the column of 2 continuation dot of drawing 1 (b). It is the same as that of the following. Moreover, the black dot of the column of the mean value dot of drawing 1 (b) comes to show a mean value dot by the above-mentioned definition. Therefore, in the case of drawing 1 (a), the enumerated data of the number of 4 and a mean value dot are set [the enumerated data of the number of an isolated dot] to 6 by the enumerated data of the count of generating of 2 and 2 continuation dot.
[0017] And the multiplication of the weighting coefficient to each pattern is carried out to each of these three enumerated data, and those three values are added to it. And the multiplication of the coefficient of the toner of C color is further carried out to the aggregate value, the amount of offset is further applied to the multiplication value, and the amount of toners of C color then consumed is calculated. Therefore, the consumption of 1 concerned page C color toner is a weighting coefficient [as opposed to the pattern of k2 and a mean value dot for a weighting coefficient / as opposed to the pattern of k1 and 2 continuation dot for the weighting coefficient to the pattern of an isolated dot] k3 It carries out and is Kc about the coefficient of the toner of C color. It carries out. C color toner consumption = Kc x{k1 x (enumerated data of the number of an isolated dot)
+ k2 x (enumerated data of the count of generating of 2 continuation dot)
+ k3 x(enumerated data of the number of mean value dot)}
+ The amount of offset of C color toner — It is set to (1).
[0018] Next, although the sequential input of the printing dot of the image of M color is carried out, counting of the number of an isolated dot, the count of generating of 2 continuation dot, and the number of a mean value dot is similarly carried out to the printing dot of the image of M color. And the multiplication of the predetermined coefficient is carried out to these three enumerated data, respectively, these three values are added, the amount of

offset is further applied to the aggregate value, and the amount of toners of M color then consumed is calculated. Therefore, the consumption of 1 concerned page M color toner is Km about the coefficient of the toner of M color. If it carries out M color toner consumption = Km x{k1 x (enumerated data of the number of an isolated dot)
+ k2 x (enumerated data of the count of generating of 2 continuation dot)
+ k3 x(enumerated data of the number of mean value dot)}
+ The amount of offset of M color toner — It is set to (2).
[0019] The same is said of the printing dot of the image of following and Y color, and the printing dot of the image of K color. Therefore, the consumption of 1 concerned page Y color toner and the consumption of K color toner are Kk about the coefficient of the toner of Ky and K color in the coefficient of the toner of Y color. It carries out and is each. Y color toner consumption = Ky x{k1 x (enumerated data of the number of an isolated dot)
+ k2 x (enumerated data of the count of generating of 2 continuation dot)
+ k3 x(enumerated data of the number of mean value dot)}
+ The amount of offset of Y color toner — (3) K color toner consumption = Kk x{k1 x (enumerated data of the number of an isolated dot)
+ k2 x (enumerated data of the count of generating of 2 continuation dot)
+ k3 x(enumerated data of the number of mean value dot)}
+ The amount of offset of K color toner — It is set to (4).
[0020] In addition, the coefficient Ky of the weighting coefficient k1 to each above-mentioned pattern, k2, k3, and the toner of each color, Km, Kc, and Kk A value The amount of toners of each color which printed about various images and was then printed by the record form is surveyed. The surveyed amount of toners, What is necessary is just to set based on the relation between the number of the isolated dot of the printing dot train of each color of the image printed at that time, the count which 2 continuation dot generates, and the number of a mean value dot etc.
[0021] Although the value of the weighting coefficient k1 to three patterns, k2, and k3 shall use the same value by the above-mentioned (1) - (4) formula, since a property changes with colors of a toner, the weighting coefficient to the pattern of an isolated dot, the weighting coefficient to the pattern of 2 continuation dot, and the weighting coefficient to the pattern of a mean value dot may be changed by the color of a toner. Moreover, in the above-mentioned explanation, although the 2nd threshold made all the same about C, M, Y, and K, it may be changed by the color.
[0022] thus, various consumption of the toner of each color for which it asked can be boiled and used. For example, when the color picture formation equipment concerned is connected to the personal computer, the calculated toner consumption is passed to a personal computer, toner consumption is integrated and memorized by the personal computer side, and it can display as a bar graph at the time of printing.
[0023] Since it is above, by this toner consumption detection method The pattern of the printing dot train of each color of a printing image An isolated dot, 2 continuation dot, It divides into three kinds of mean value dots. The number of an isolated dot, the count of generating of 2 continuation dot, Carry out counting of the number of a mean value dot, and carry out the multiplication of the weighting coefficient to each pattern to these three enumerated data, and it is added to them. The multiplication of the coefficient according to the color of a toner is carried out to the aggregate value, and since what is necessary is just to perform processing in which the amount of offset is added to the multiplication value, it is realizable with an easy configuration so that it may mention later. Moreover, since this toner consumption detection method detects toner consumption based on a printing dot train, it is not based on the pulse modulation method which generates the pulse for driving a laser beam, but can be applied also to the equipment which uses a Pulse-Amplitude-Modulation (Pulse Amplitude Modulation) method also for the equipment using PWM, or the equipment of the hybrid configuration which combined PWM and Pulse Amplitude Modulation.
[0024] One operation gestalt of [the toner consumption detection equipment which adopted the 1st toner consumption detection method], next the toner consumption detection equipment which detects toner consumption by the toner consumption detection method mentioned above is explained. In addition, 1 printing dot presupposes that they are 6 bit patterns here.
[0025] Drawing 2 is drawing showing the partial block diagram of 1 operation gestalt at the time of applying toner consumption detection equipment to a color laser beam printer. 1 — toner consumption detection equipment and 2 — the 1st comparison circuit and 3 — the 2nd comparison circuit and 4 — a dot array pattern distinction circuit (a distinction circuit is only called hereafter) and 5 — in the 1st counter and 6, the 4th counter and 9 show an arithmetic circuit and, as for the 2nd counter and 7, 10 shows a pulse modulation circuit, as for the 3rd counter and 8. In addition, a color laser beam printer presupposes that it is the thing of the type with which the development counter of four colors of C, M, Y, and K has been arranged around one photo conductor here. In this type of color laser beam printer, it is common knowledge to form the electrostatic latent image of four colors of C, M, Y, and K in one photo conductor by one laser beam. Moreover, the configuration of this type of the whole color laser beam printer is common knowledge, and since it moreover is not the essence of this invention, in drawing 2 , the graphic display is omitted about the photo conductor or the development counter.
[0026] Hereafter, each part shown in drawing 2 is explained. The 1st comparison circuit 2 is the value and the 1st threshold Vth1 of a printing dot to input. It compares, the printing dot which has a value beyond the 1st threshold is outputted to the distinction circuit 4, and it is this 1st threshold Vth1. It is 1 in a gradation value.
[0027] The 2nd comparison circuit 3 is the value and the 2nd threshold Vth2 of a printing dot to input. It compares,

the printing dot which has a value beyond the 2nd threshold is outputted to the distinction circuit 4, and it is the 2nd threshold Vth2 here. It is referred to as 48 with a gradation value.
[0028] The distinction circuit 4 is based on the train of the value of the printing dot by which a sequential input is carried out from the 1st comparison circuit 2 and the 2nd comparison circuit 3. When the value of a printing dot is beyond the 1st threshold and the value of a printing dot is beyond the 2nd threshold, It is what distinguishes the case where it is four in the case of being an isolated dot when 2 continuation dot has occurred. Whenever a gradation value detects the printing dot beyond the 2nd threshold, 1 is outputted to the 1st counter 5 every. Whenever it detects that 2 continuation dot occurred, 1 is outputted to the 2nd counter 6 every, whenever it detects an isolated dot, 1 is outputted to the 3rd counter 7 every, and whenever it detects the printing dot whose gradation value is beyond the 1st threshold, 1 is outputted to the 4th counter 8 every. Therefore, about 48 or more printing dots whose gradation values are the 2nd threshold, 1 will be outputted to both the 1st counter 5 and the 4th counter 8 at least in this case.
[0029] The 1st counter 5, the 2nd counter 6, the 3rd counter 7, and the 4th counter 8 will perform actuation which counts up only 1, respectively, if the distinction circuits 4-1 are outputted. In addition, a control signal is notified to these four counters from the control section which manages processing of the color picture formation which is not illustrated, respectively. There are a start signal which notifies transfer initiation of a printing dot, and an end signal which notifies transfer termination of a printing dot in this control signal. And if a start signal is received, these four counters will start counting of the output from the distinction circuit 4, and will pass signal ****** and enumerated data to an arithmetic circuit 9, and will clear enumerated data. Supposing there is an array of a printing dot as followed, for example, shown in drawing 1 (a), the distinction circuit 4 As the black dot of the column of the 1st counter of drawing 1 (c) shows to the 1st counter 5, the enumerated data in the 1st counter 5 in the period of the printing dot train which will output 1, respectively at the time of the 2nd, the 6-10th, and the 13th printing dot, therefore is shown in drawing 1 (a) are set to 7. The same is said of the 2nd counter 6 - the 4th counter 8.
[0030] A control signal is notified to an arithmetic circuit 9 from the control section which manages processing of the color picture formation which is not illustrated. There are a chrominance signal which shows of which color the process performed now is a thing, a start signal which notifies transfer initiation of a printing dot, and an end signal which notifies transfer termination of a printing dot in this control signal. Therefore, although an arithmetic circuit 9 receives enumerated data from the 1st counter 5 - the 4th counter 8, the arithmetic circuit 9 recognizes whether the enumerated data received from each counters 5-8 are the things about the image of which color with the chrominance signal from a control section.
[0031] And an arithmetic circuit 9 calculates the enumerated data of the number of an isolated dot, the enumerated data of the count of generating of 2 continuation dot, and the enumerated data of the number of a mean value dot based on carrier beam enumerated data from the 1st counter 5 - the 4th counter 8. The enumerated data of the number of an isolated dot are the enumerated data of the 3rd counter 7 itself. The enumerated data of the count of generating of 2 continuation dot are the enumerated data of the 2nd counter 6 itself. Moreover, the enumerated data of the number of a mean value dot can be calculated with the value which subtracted the enumerated data of the 1st counter 5 from the enumerated data of the 4th counter 8.
[0032] And an arithmetic circuit 9 is the weighting coefficient [as opposed to each pattern to the enumerated data of the enumerated data of the number of an isolated dot, the enumerated data of the count of generating of 2 continuation dot, and the enumerated data of the number of a mean value dot] k1, k2, and k3. Multiplication is carried out. These three values are added, the multiplication of the coefficient according to the color of a toner is further carried out to the aggregate value, the amount of offset according to the color of a toner is further added to it, and the toner consumption of the color concerned in this print is calculated. In addition, the weighting coefficient k1 to these three patterns, k2, and k3 A value, the coefficient Ky of the toner of each color, Km, Kc, and Kk The value and the amount of offset of each color are beforehand set as the arithmetic circuit 9.
[0033] The pulse modulation circuit 10 may be the thing of the hybrid configuration which generates the pulse which drives a laser beam based on a printing dot, and combined them using Pulse Amplitude Modulation using PWM.
[0034] Hereafter, although actuation is explained, the process of color picture formation shall be performed in order of C, M, Y, and K here. First, although the process of color picture formation of C is performed, a start signal is notified to the 1st counter 5 - the 4th counter 8 from a control section at this time, and the chrominance signal and start signal which show that it is color picture formation of C from a control section are notified to an arithmetic circuit 9.
[0035] And a transfer of the printing dot of the image of C is started and this printing dot is inputted into the 1st comparison circuit 2, the 2nd comparison circuit 3, and the pulse modulation circuit 10. In the pulse modulation circuit 10, pulse modulation is performed based on the value of each printing dot, and the generated pulse is supplied to a laser actuator (not shown to drawing 2).
[0036] Moreover, for the 1st comparison circuit 2, the value of the printing dot to input is the 1st threshold Vth1. The value of the printing dot which outputs the value of that printing dot to the distinction circuit 4, and inputs the 2nd comparison circuit 3 in being above is the 2nd threshold Vth2. In being above, it performs actuation which outputs the value of this printing dot to the distinction circuit 4.
[0037] And the distinction circuit 4 is based on the train of the value of the printing dot by which sequential supply is carried out from the 1st comparison circuit 2 and the 2nd comparison circuit 3. When the value of a printing dot is beyond the 1st threshold and the value of a printing dot is beyond the 2nd threshold, It is what distinguishes the case where it is four in the case of being an isolated dot when 2 continuation dot has occurred. Whenever a

gradation value detects the printing dot beyond the 2nd threshold, 1 is outputted to the 1st counter 5 every. Whenever it detects that 2 continuation dot occurred, 1 is outputted to the 2nd counter 6 every, whenever it detects an isolated dot, 1 is outputted to the 3rd counter 7 every, and whenever it detects the printing dot whose gradation value is beyond the 1st threshold, actuation which outputs 1 to the 4th counter 8 every is performed.
[0038] Whenever the distinction circuits 4-1 are outputted, the 1st counter 5 - the 4th counter 8 repeat the actuation counted up every, after receiving a start signal until it receives a signal. and the 1st counter 5 - the 4th counter 8 — and — if a signal is received — the enumerated data at that time — an arithmetic circuit 9 — passing — enumerated data — clearing — the following counting — actuation is stood by.
[0039] If enumerated data are received from the 1st counter 5 - the 4th counter 8, since it recognizes that the enumerated data concerned are the enumerated data about the printing dot of the image of C, an arithmetic circuit 9 will calculate the consumption of C color toner at this time by the following formula.
C color toner consumption = Kc x{k1 x (enumerated data of the 3rd counter)
+ k2 x (enumerated data of the 2nd counter)
+ k3 x(enumerated data of the enumerated-data-1st counter of 4th counter)}
+ the amount of offset of C color toner — (5) — although the process of the image formation of M is started after doing in this way and completing the process of the image formation of C next, a start signal is notified to the 1st counter 5 - the 4th counter 8 from a control section at this time, and the chrominance signal and start signal which show that it is color picture formation of C from a control section are notified to an arithmetic circuit 9.
[0040] And a transfer of the printing dot of the image of M is started and this printing dot is inputted into the 1st comparison circuit 2, the 2nd comparison circuit 3, and the pulse modulation circuit 10. In the pulse modulation circuit 10, pulse modulation is performed based on the value of each printing dot, and the generated pulse is supplied to a laser actuator.
[0041] Moreover, for the 1st comparison circuit 2, the value of the printing dot to input is the 1st threshold Vth1. The value of the printing dot which outputs the value of that printing dot to the distinction circuit 4, and inputs the 2nd comparison circuit 3 in being above is the 2nd threshold Vth2. In being above, it performs actuation which outputs the value of this printing dot to the distinction circuit 4.
[0042] And the distinction circuit 4 is based on the train of the value of the printing dot by which sequential supply is carried out from the 1st comparison circuit 2 and the 2nd comparison circuit 3. When the value of a printing dot is beyond the 1st threshold and the value of a printing dot is beyond the 2nd threshold, It is what distinguishes the case where it is four in the case of being an isolated dot when 2 continuation dot has occurred. Whenever a gradation value detects the printing dot beyond the 2nd threshold, 1 is outputted to the 1st counter 5 every. Whenever it detects that 2 continuation dot occurred, 1 is outputted to the 2nd counter 6 every, whenever it detects an isolated dot, 1 is outputted to the 3rd counter 7 every, and whenever it detects the printing dot whose gradation value is beyond the 1st threshold, actuation which outputs 1 to the 4th counter 8 every is performed.
[0043] Whenever the distinction circuits 4-1 are outputted, the 1st counter 5 - the 4th counter 8 repeat the actuation counted up every, after receiving a start signal until it receives a signal. and the 1st counter 5 - the 4th counter 8 — and — if a signal is received — the enumerated data at that time — an arithmetic circuit 9 — passing — enumerated data — clearing — the following counting — actuation is stood by.
[0044] If enumerated data are received from the 1st counter 5 - the 4th counter 8, since it recognizes that the enumerated data concerned are the enumerated data about the printing dot of the image of M, an arithmetic circuit 9 will calculate the consumption of M color toner at this time by the following formula.
M color toner consumption = Km x{k1 x (enumerated data of the 3rd counter)
+ k2 x (enumerated data of the 2nd counter)
+ k3 x(enumerated data of the enumerated-data-1st counter of 4th counter)}
+ The amount of offset of M color toner — (6) [0045] Next, although the process of the image formation of Y is performed, and the process of the image formation of K is performed continuously, the toner consumption of Y color and the toner consumption of K color are calculated similarly also at the time of these image formation processes. The consumption of Y color toner at this time and the consumption of K color toner are as follows respectively.
[0046]
Y color toner consumption = Ky x{k1 x (enumerated data of the 3rd counter)
+ k2 x (enumerated data of the 2nd counter)
+ k3 x(enumerated data of the enumerated-data-1st counter of 4th counter)}
+ The amount of offset of Y color toner — (7) K color toner consumption = Kk x{k1 x (enumerated data of the 3rd counter)
+ k2 x (enumerated data of the 2nd counter)
+ k3 x(enumerated data of the enumerated-data-1st counter of 4th counter)}
+ The amount of offset of K color toner — (8) [0047] In addition, although the operation of the toner consumption of each color is performed for every formation process of one color image in the above example since the case where the electrostatic latent image of four colors of C, M, Y, and K was applied to the color laser beam printer of the type formed in one photo conductor by one laser beam was explained In applying to the so-called tandem type equipped with four sets of a photo conductor and a development counter of thing Although it is also possible to calculate toner consumption per one print, of course since what is necessary is just to form this toner consumption detection equipment in the system of four image formation processes, C, M, Y, and K, respectively It is also possible to calculate toner consumption in an unit with proper job unit or one-day unit etc. In that case, naturally it is

necessary to change suitably the gestalt of the control signal notified to four counters and an arithmetic circuit 9 according to the unit which calculates toner consumption.
[0048] The weighting coefficient [as opposed to three patterns by the above-mentioned explanation] k1, k2, and k3 Although the value shall use the same value, since a property changes with colors of a toner, the weighting coefficient to the pattern of an isolated dot, the weighting coefficient to the pattern of 2 continuation dot, and the weighting coefficient to the pattern of a mean value dot may be changed by the color of a toner.
[0049] What is necessary is just to give the data of the consumption of the toner of each color for which it asked in the arithmetic circuit 9 to a means to manage the processing which performs the display of toner consumption or a toner residue. In the printing screen of the personal computer which gives by this the image data printed on the color laser beam printer concerned, if it has the proper display function to the printer concerned itself possible [displaying the consumption or the residue of a toner of each color with proper graphs, such as a bar graph], it is possible to display the consumption or the residue of a toner of each color using the display function.
[0050] Since it is above, according to this toner consumption detection equipment, the toner consumption of each color can be calculated with an easy configuration, and it is possible to apply to the thing using any pulse modulation methods moreover.
[0051] The [2nd toner consumption detection method], next the 2nd amount detection method of toners are explained. In addition, about an isolated dot, 2 continuation dot, a mean value dot, the 1st threshold, and the 2nd threshold, it is the same in having mentioned above.
[0052] This 2nd method is amelioration of the 1st method mentioned above. By the 1st method, the pattern of the array of a printing dot train Although it classified into three kinds, an isolated dot, 2 continuation dot, and a mean value dot, and the consumption of the toner of each color was detected based on three enumerated data, the enumerated data of the number of an isolated dot, the enumerated data of the count of generating of 2 continuation dot, and the enumerated data of the number of a mean value dot He is trying to also distinguish 3 continuation dot by this 2nd method in addition to three kinds of above-mentioned patterns. Here, 3 continuation dot shall mean the case where three printing dots whose gradation values are beyond the 2nd threshold continue.
[0053] To 2 continuation dot, in addition, also distinguishing 3 continuation dot By for example, three cases where two printing dots of the maximum gradation are continuing and the case where it is continuing Since the latter toner consumption has the phenomenon of increasing more than it instead of 3/2 of the former toner consumption a little, it is because it is thought that toner consumption can be detected with a more sufficient precision by distinguishing 2 continuation dot and 3 continuation dot.
[0054] Specifically, it is as follows. Now, the toner consumption of each color shall be detected per 1 page. Moreover, the process of color picture formation shall be performed in order of C, M, Y, and K.
[0055] In this case, counting of the number of an isolated dot, the count of generating of 2 continuation dot, the count of generating of 3 continuation dot, and the number of a mean value dot is first carried out about the printing dot of the image of C color which carries out a sequential input. For example, it carries out to it seeming that the printing dot train of the image of C color shows now drawing 3 (a). In addition, drawing 3 (a) is the same as drawing 1 (a). 1 printing dots are 6 bit patterns, and are taken as the 1st threshold Vth 1= 1 and the 2nd threshold Vth 2= 48 also here.
[0056] About an isolated dot, 2 continuation dot, and a mean value dot, it is the same in having explained by the 1st method. About 3 continuation dot, it is as follows. The gradation value of the 6th printing dot is beyond the 2nd threshold, and both the gradation values of the 7th and the 8th following printing dot are also beyond the 2nd threshold. Therefore, since the printing dot beyond the 2nd threshold is following [the gradation value] the 6th, the 7th, and the 8th, 3 continuation dot has occurred once here. It shows this that the black dot is attached to the part of the 8th printing dot of the column of 3 continuation dot of drawing 3 (b). Similarly, since each gradation value of the 7th, the 8th, and the 9th printing dot is beyond the 2nd threshold, 3 continuation dot has occurred once also here. It shows this that the black dot is attached to the part of the 9th printing dot of the column of 3 continuation dot of drawing 3 (b). It is the same as that of the following. Therefore, in the case of drawing 3 (a), the enumerated data of the number of 3 and a mean value dot are set [the enumerated data of the number of an isolated dot / the enumerated data of the count of generating of 2 and 2 continuation dot] to 6 by the enumerated data of the count of generating of 4 and 3 continuation dot.
[0057] And the multiplication of the weighting coefficient to each pattern is carried out to these four enumerated data, respectively, and those four values are added. And the multiplication of the coefficient of the toner of C color is further carried out to the aggregate value, the amount of offset is further applied to the multiplication value, and the amount of toners of C color then consumed is calculated. Therefore, the consumption of 1 concerned page C color toner A weighting coefficient [as opposed to the pattern of k1 and 2 continuation dot for the weighting coefficient to the pattern of an isolated dot] k2, It is a weighting coefficient [as opposed to the pattern of k3 and a mean value dot for the weighting coefficient to the pattern of 3 continuation dot] k4 It carries out and is Kc about the coefficient of the toner of C color. It carries out. C color toner consumption = Kc x{k1 x (enumerated data of the number of an isolated dot)
+ k2 x (enumerated data of the count of generating of 2 continuation dot)
+ k3 x (enumerated data of the count of generating of 3 continuation dot)
+ k4 x(enumerated data of the number of mean value dot)}
+ The amount of offset of C color toner — It is set to (9).
[0058] Next, although the sequential input of the printing dot of the image of M color is carried out, counting of the

number of an isolated dot, the count of generating of 2 continuation dot, the count of generating of 3 continuation dot, and the number of a mean value dot is similarly carried out to the printing dot of the image of M color. And the multiplication of the weighting coefficient to each pattern is carried out to these four enumerated data, respectively, and those four values are added. and — further — the aggregate value — the coefficient of the toner of M color — multiplication — carrying out — further — the multiplication value — the amount of offset — in addition, the amount of toners of M color then consumed is calculated. Therefore, the consumption of 1 concerned page C color toner is Km about the coefficient of the toner of M color. It carries out. M color toner consumption = Km x{k1 x (enumerated data of the number of an isolated dot)
+ k2 x (enumerated data of the count of generating of 2 continuation dot)
+ k3 x (enumerated data of the count of generating of 3 continuation dot)
+ k4 x(enumerated data of the number of mean value dot)}
+ The amount of offset of M color toner — It is set to (10).
[0059] The same is said of the printing dot of the image of following and Y color, and the printing dot of the image of K color. Therefore, the consumption of 1 concerned page Y color toner and the consumption of K color toner are Kk about the coefficient of the toner of Ky and K color in the coefficient of the toner of Y color. It carries out and is each. Y color toner consumption = Ky x{k1 x (enumerated data of the number of an isolated dot)
+ k2 x (enumerated data of the count of generating of 2 continuation dot)
+ k3 x (enumerated data of the count of generating of 3 continuation dot)
+ k4 x(enumerated data of the number of mean value dot)}
+ The amount of offset of Y color toner — (11) K color toner consumption = Kk x{k1 x (enumerated data of the number of an isolated dot)
+ k2 x (enumerated data of the count of generating of 2 continuation dot)
+ k3 x (enumerated data of the count of generating of 3 continuation dot)
+ k4 x(enumerated data of the number of mean value dot)}
+ The amount of offset of K color toner — It is set to (12).
[0060] In addition, the weighting coefficient k1 to each above-mentioned pattern, k2, k3, and k4 And the coefficient Ky of the toner of each color, Km, Kc, and Kk A value The amount of toners of each color which printed about various images and was then printed by the record form is surveyed. The surveyed amount of toners, What is necessary is just to set based on the relation between the number of the isolated dot of the printing dot train of each color of the image printed at that time, the count which 2 continuation dot generates, the count which 3 continuation dot generates, and the number of a mean value dot etc.
[0061] The weighting coefficient [as opposed to four patterns at the above-mentioned (9) - (12) type] k1, k2, and k3 and k4 Although the value shall use the same value A weighting coefficient [as opposed to the pattern of an isolated dot by the color of a toner] since a property changes with colors of a toner, The weighting coefficient to the pattern of 2 continuation dot, the weighting coefficient to the pattern of 3 continuation dot, and the weighting coefficient to the pattern of a mean value dot may be changed. Moreover, in the above-mentioned explanation, although the 2nd threshold made all the same about C, M, Y, and K, it may be changed by the color. in addition, as for various consumption of the toner of each color for which carried out in this way and it asked, it is same in having mentioned above that it can be alike and can use.
[0062] Since it is above, by this toner consumption detection method The pattern of the printing dot train of each color of a printing image An isolated dot, 2 continuation dot, It divides into four kinds of 3 continuation dot and a mean value dot. The number of an isolated dot,. Counting of the count of generating of 2 continuation dot, the count of generating of 3 continuation dot, and the number of a mean value dot is carried out. Since what is necessary is just to perform processing in which carry out the multiplication of the weighting coefficient to each pattern to these four enumerated data, and add it to them, and carry out the multiplication of the coefficient according to the color of a toner to the aggregate value, and the amount of offset is added to the multiplication value, it is realizable with an easy configuration so that it may mention later. Moreover, since this toner consumption detection method detects toner consumption based on a printing dot train, it is not based on the pulse modulation method which generates the pulse for driving a laser beam, but can be applied also to the equipment which uses a Pulse-Amplitude-Modulation (Pulse Amplitude Modulation) method also for the equipment using PWM, or the equipment of the hybrid configuration which combined PWM and Pulse Amplitude Modulation.
[0063] One operation gestalt of [the toner consumption detection equipment which adopted the 2nd toner consumption detection method], next the toner consumption detection equipment which detects toner consumption by the 2nd toner consumption detection method mentioned above is explained. In addition, 1 printing dot presupposes that they are 6 bit patterns here.
[0064] Drawing 4 is drawing showing the partial block diagram of 1 operation gestalt at the time of applying toner consumption detection equipment to a color laser beam printer. Although the configuration shown in drawing 4 is the same as that of what is shown in drawing 2 , a part of the actuation differs. In drawing 4 , in 11, a dot array pattern distinction circuit (a distinction circuit is only called hereafter) and 13 show the 2nd counter, and, as for toner consumption detection equipment and 12, 14 shows an arithmetic circuit. In addition, in drawing 4 , the explanation which attaches the same sign and overlaps about the same thing as what is shown in drawing 2 will be minimized. Moreover, although [here / a color laser beam printer] it is the thing of the type with which the development counter of four colors of C, M, Y, and K has been arranged around one photo conductor, the configuration of this type of the whole color laser beam printer is common knowledge, and since it moreover is not the essence of this

invention, by drawing 4 , the graphic display is omitted about the photo conductor or the development counter.
[0065] The distinction circuit 12 is based on the train of the value of the printing dot by which a sequential input is carried out from the 1st comparison circuit 2 and the 2nd comparison circuit 3. When the value of a printing dot is beyond the 1st threshold and the value of a printing dot is beyond the 2nd threshold, It is what distinguishes the case where it is four in the case of being an isolated dot when 3 continuation dot has occurred. Whenever a gradation value detects the printing dot beyond the 2nd threshold, 1 is outputted to the 1st counter 5 every. Whenever it detects that 3 continuation dot occurred, 1 is outputted to the 2nd counter 13 every, whenever it detects an isolated dot, 1 is outputted to the 3rd counter 7 every, and whenever it detects the printing dot whose gradation value is beyond the 1st threshold, 1 is outputted to the 4th counter 8 every.
[0066] The 1st counter 5, the 2nd counter 13, the 3rd counter 7, and the 4th counter 8 will perform actuation which counts up only 1, respectively, if the distinction circuits 12-1 are outputted. In addition, a control signal is notified to these four counters from the control section which manages processing of the color picture formation which is not illustrated, respectively. There are a start signal which notifies transfer initiation of a printing dot, and an end signal which notifies transfer termination of a printing dot in this control signal. And if a start signal is received, these four counters will start counting of the output from the distinction circuit 12, and will pass signal ****** and enumerated data to an arithmetic circuit 14, and will clear enumerated data. Supposing there is an array of a printing dot as followed, for example, shown in drawing 3 (a), the distinction circuit 12 As the black dot of the column of the 1st counter of drawing 1 (c) shows to the 1st counter 5, the enumerated data in the 1st counter 5 in the period of the printing dot train which will output 1, respectively at the time of the 2nd, the 6-10th, and the 13th printing dot, therefore is shown in drawing 1 (a) are set to 7. The same is said of the 2nd counter 13, the 3rd counter 7, and the 4th counter 8.
[0067] A control signal is notified to an arithmetic circuit 14 from the control section which manages processing of the color picture formation which is not illustrated. There are a chrominance signal which shows of which color the process performed now is a thing, a start signal which notifies transfer initiation of a printing dot, and an end signal which notifies transfer termination of a printing dot in this control signal. Therefore, although an arithmetic circuit 14 receives enumerated data from the 1st - the 4th counter, the arithmetic circuit 14 recognizes whether the enumerated data received from each counter are the things about the image of which color with the chrominance signal from a control section.
[0068] And an arithmetic circuit 14 calculates the enumerated data of the number of an isolated dot, the enumerated data of the count of generating of 2 continuation dot, the enumerated data of the count of generating of 3 continuation dot, and the enumerated data of the number of a mean value dot based on carrier beam enumerated data from the 1st counter - the 4th counter. The enumerated data of the number of an isolated dot are the enumerated data of the 3rd counter 7 itself. The enumerated data of the count of generating of 3 continuation dot are the enumerated data of the 2nd counter 13 itself. Moreover, the enumerated data of the count of generating of 2 continuation dot can be calculated with the value which subtracted the enumerated data of the 2nd counter, and the enumerated data of the 3rd counter from the enumerated data of the 1st counter 5. Furthermore, the enumerated data of the number of a mean value dot can be calculated with the value which subtracted the enumerated data of the 1st counter 5 from the enumerated data of the 4th counter 8.
[0069] An arithmetic circuit 14 And enumerated data of the number of an isolated dot, enumerated data of the count of generating of 2 continuation dot, The weighting coefficient [respectively as opposed to each pattern to four enumerated data of the enumerated data of the count of generating of 3 continuation dot, and the enumerated data of the number of a mean value dot] k1, k2, k3, and k4 Multiplication is carried out. These four values are added, the multiplication of the coefficient according to the color of a toner is further carried out to the aggregate value, the amount of offset according to the color of a toner is further added to it, and the toner consumption of the color concerned in this print is calculated. In addition, the weighting coefficient k1 to these four patterns, k2, k3, and k4 A value, the coefficient Ky of the toner of each color, Km, Kc, and Kk The value and the amount of offset of each color are beforehand set as the arithmetic circuit 14.
[0070] Hereafter, although actuation is explained, the process of color picture formation shall be performed in order of C, M, Y, and K here. First, although the process of color picture formation of C is performed, a start signal is notified to the 1st counter 5 - the 4th counter 8 from a control section at this time, and the chrominance signal and start signal which show that it is color picture formation of C from a control section are notified to an arithmetic circuit 14.
[0071] And a transfer of the printing dot of the image of C is started and this printing dot is inputted into the 1st comparison circuit 2, the 2nd comparison circuit 3, and the pulse modulation circuit 10. In the pulse modulation circuit 10, pulse modulation is performed based on the value of each printing dot, and the generated pulse is supplied to a laser actuator (not shown to drawing 4).
[0072] Moreover, for the 1st comparison circuit 2, the value of the printing dot to input is the 1st threshold Vth1. The value of the printing dot which outputs the value of that printing dot to the distinction circuit 12, and inputs the 2nd comparison circuit 3 in being above is the 2nd threshold Vth2. In being above, it performs actuation which outputs the value of this printing dot to the distinction circuit 12.
[0073] And the distinction circuit 12 is based on the train of the value of the printing dot by which sequential supply is carried out from the 1st comparison circuit 2 and the 2nd comparison circuit 3. When the value of a printing dot is beyond the 1st threshold and the value of a printing dot is beyond the 2nd threshold, It is what distinguishes the case where it is four in the case of being an isolated dot when 3 continuation dot has occurred. Whenever a

gradation value detects the printing dot beyond the 2nd threshold, 1 is outputted to the 1st counter 5 every. Whenever it detects that 3 continuation dot occurred, 1 is outputted to the 2nd counter 13 every, whenever it detects an isolated dot, 1 is outputted to the 3rd counter 7 every, and whenever it detects the printing dot whose gradation value is beyond the 1st threshold, actuation which outputs 1 to the 4th counter 8 every is performed.
[0074] Whenever the distinction circuits 12-1 are outputted, the 1st counter 5 - the 4th counter 8 repeat the actuation counted up every, after receiving a start signal until it receives a signal. and the 1st counter 5 - the 4th counter 8 — and — if a signal is received — the enumerated data at that time — an arithmetic circuit 14 — passing — enumerated data — clearing — the following counting — actuation is stood by.
[0075] If enumerated data are received from the 1st counter 5 - the 4th counter 8, an arithmetic circuit 14 Since it recognizes that the enumerated data concerned are the enumerated data about the printing dot of the image of C They are [enumerated data / of the 1st counter 5] the enumerated data of c3 and the 4th counter 8 about the enumerated data of c2 and the 3rd counter 7 in the enumerated data of c1 and the 2nd counter 13 c4 It carries out and the consumption of C color toner at this time is calculated by the following formula.
C color toner consumption =Kcx{k1xc3+k2x(c1-c2-c3)+k3xc2 + The amount of offset of a k4x(c4-c1)}+C color toner — (13) Here k1 The weighting coefficient and k2 to the pattern of an isolated dot The weighting coefficient and k3 to the pattern of 2 continuation dot The weighting coefficient and k4 to the pattern of 3 continuation dot It is a weighting coefficient to the pattern of a mean value dot.
[0076] Thus, although image formation of M is performed, the process of the image formation of Y is performed to the degree and the process of the image formation of K is further performed to it after the process of the image formation of C is completed next, an arithmetic circuit 14 calculates the toner consumption of M color, the toner consumption of Y color, and the toner consumption of K color by the following formula similarly also at the time of these image formation processes.
[0077]
M color toner consumption =Kmx{k1xc3+k2x(c1-c2-c3)+k3xc2 + The amount of offset of a k4x(c4-c1)}+M color toner — (14) Y color toner consumption =Kyx{k1xc3+k2x(c1-c2-c3)+k3xc2 + The amount of offset of a k4x(c4-c1)} +Y color toner — (15) K color toner consumption =Kkx{k1xc3+k2x(c1-c2-c3)+k3xc2 The amount of offset of a +k4x (c4-c1)}+K color toner — (16) [0078] The weighting coefficient [as opposed to / as mentioned above / four patterns] k1, k2, k3, and k4 A value and the coefficient Ky of the toner of each color, Km, Kc, and Kk Although a value can be calculated by experiment When 1 printing dot considers as 6 bit patterns and the 2nd threshold Vth 2= 48 according to the experiment of this invention person, k1 =0.76 — (17) k2 =1.00 — (18) k3 =1.10 — (19) k4 =0.30 — (20) Kc =9.20x10-6 — (21) Km =10.50x10-6 — (22) Ky =9.95x10-6 — (23) Kk =12.53x10-6 — (24) was obtained. When calculating (13) - (16) type using these values, it was checked that the toner consumption of each color can be calculated in the unit of mg.
[0079] In addition, although the operation of the toner consumption of each color is performed for every formation process of one color image in the above example since the case where the electrostatic latent image of four colors of C, M, Y, and K was applied to the color laser beam printer of the type formed in one photo conductor by one laser beam was explained In applying to the so-called tandem type equipped with four sets of a photo conductor and a development counter of thing Although it is also possible to calculate toner consumption per one print, of course since what is necessary is just to form this toner consumption detection equipment in the system of four image formation processes, C, M, Y, and K, respectively It is also possible to calculate toner consumption in an unit with proper job unit or one-day unit etc. In that case, naturally it is necessary to change suitably the gestalt of the control signal notified to four counters and an arithmetic circuit 14 according to the unit which calculates toner consumption.
[0080] In addition, the weighting coefficient [as opposed to four patterns by the above-mentioned explanation] k1, k2, and k3 and k4 Although the value shall use the same value A weighting coefficient [as opposed to the pattern of an isolated dot by the color of a toner] since a property changes with colors of a toner, The weighting coefficient to the pattern of 2 continuation dot, the weighting coefficient to the pattern of 3 continuation dot, and the weighting coefficient to the pattern of a mean value dot may be changed.
[0081] About the method of utilization of the data of the consumption of the toner of each color for which it asked in the arithmetic circuit 14, it is the same in having mentioned above.
[0082] Since it is above, according to this toner consumption detection equipment, the toner consumption of each color can be calculated with an easy configuration, and it is possible to apply to the thing using any pulse modulation methods moreover.
[0083] A [experimental result], next the experimental result which this invention person performed are shown in drawing 5 . Drawing 5 is drawing showing the relation between the theoretical value of the toner consumption per sheet when printing 19 various images, such as an image containing both the graphic image and natural image containing many natural images, such as a landscape, geometric figures, etc., and a graphic image, and the actual measurement of the amount of toners actually consumed at the time of a print. In addition, in this experiment, 1 printing dots are 6 bit patterns, and are the 1st threshold Vth 1= 1 and the 2nd threshold Vth 2= 48.
[0084] Here, the theoretical value of toner consumption is the consumption of the toner of each color for which it asked by (13) - (16) type using the value of above-mentioned (17) - (24). The consumption of M toner and drawing 5 (c) show the consumption of C color toner, drawing 5 (d) shows the consumption of K color toner, a horizontal axis is a theoretical value per sheet, the axis of ordinate of all is an actual measurement per sheet, and the consumption of Y color toner and drawing 5 (b) are [units of drawing 5 (a)] mg(s). Moreover, every point of the

image with which each which is plotted at the white round head or black rectangular head of drawing 5 (a) - (d) printed, respectively is shown, and 19 points are plotted by each of drawing 5 (a) - (d). Moreover, although the equation "y=1.0000x-0.0002" is indicated by drawing 5 (a), this is a linear equation shown in drawing 5 (a) when a horizontal axis is set to x and it sets an axis of ordinate to y. Moreover, although the publication "R2 =0.9831" is shown in drawing 5 (a), this is a correlation coefficient when searching for the correlation of a theoretical value and an actual measurement about 19 points currently plotted. Drawing 5 (b) The same is said of - (d).

[0085] Then, if drawing 5 (a) - (d) is seen, as for the correlation coefficient of a theoretical value and an actual measurement, it turns out about the toner of all colors that near and the point currently plotted are good on one straight line, and it has ridden 1. it is shown that this, i.e., a theoretical value, suits the actual measurement well — **** — it does not become others.

[0086] Next, drawing 6 is shown for drawing 5 and a comparison. Drawing 6 is drawing showing the relation between the theoretical value of the toner consumption when printing the 19 same images, and the actual measurement of the amount of toners actually consumed at the time of a print with having printed by drawing 5 . Although it is ** and the 1st threshold Vth 1= 1 in 1 printing dot ** h6 bit pattern also in this experiment, it is made with the 2nd threshold Vth 2= 63. That is, in this experiment, the 2nd threshold is made with the maximum gradation value. In addition, the semantics of an equation and the semantics of a correlation coefficient are the same as drawing 5 .

[0087] Drawing 6 (a) When - (d) is seen, it turns out that there is a plot which is separated from the straight line, and that it is worse than what a correlation coefficient shows to drawing 5 . The above thing shows that it is useful to set the 2nd threshold to 48 with a gradation value, when 1 printing dots are 6 bit patterns.

[0088] thus, the case where 1 printing dots are 6 bit patterns — the 2nd threshold Vth2 although the theoretical explanation about what it can be referred to as 48 with a gradation value, the pattern of a printing dot train can be divided into four patterns, an isolated dot, 2 continuation dot, 3 continuation dot, and a mean value dot, and (9) - (12) type can detect toner consumption with a sufficient precision for is dramatically difficult — an outline — it is thought that the following can be said.

[0089] When 1 printing dots are 6 bit patterns, as are mentioned above, and a gradation value shows 48 by P in drawing 7 , supporting the gradation value near [with the longer laser luminescence time amount in the graph which shows the relation between laser luminescence time amount and toner consumption] the point of inflection is checked. And when it is going to set up a threshold, adopting the point of inflection of a graph or the value of the near generally in many cases is known well. Moreover, the printing dot of the gradation value of P or more points can be considered that the amount of toners consumed is equivalent so that clearly also from the property of the continuous line of drawing 7 . From the above thing, when 1 printing dots are 6 bit patterns, it is considered that there is validity to set the 2nd threshold to 48 with a gradation value.

[0090] However, it is desirable to distinguish the case of an isolated dot, the case of 2 continuation dot, and the case of 3 continuation dot for the reason mentioned above, even if a value is a printing dot beyond the 2nd threshold. From this, there is validity of a value dividing into three patterns, an isolated dot, 2 continuation dot, and 3 continuation dot, about the printing dot beyond the 2nd threshold.

[0091] As mentioned above, from the property of the continuous line of drawing 7 , although it is possible that the amount of toners in which a value is consumed about the printing dot beyond the 2nd threshold is equivalent, since it cannot say, that a value is such about the printing dot of under the 2nd threshold must carry out another handling. This is a mean value dot.

[0092] By the way, although what is shown with the dashed line of drawing 7 connects the ends of the property shown as a continuous line and it is the case where the property of laser luminescence time amount and toner consumption is linearity, the toner consumption of a mean value dot with a small value is smaller than the case of a linearity property, and the toner consumption of a mean value dot with a large value will become [many] from the case of a linearity property. If the average of the value of a mean value dot is taken when are seen about the value of each printing dot from this and many printing dots are seen as a whole like an one image unit although the value of a printing dot and the relation of toner consumption are nonlinear to be sure, it will be expected whether the average is settled in a certain specific value. Then, the printing dot which a value is beyond the 1st threshold and is under the 2nd threshold is considered that there is validity of treating in all together as a mean value dot.

[0093] As mentioned above, when 1 printing dots are 6 bit patterns, this invention person from the above thing as the 1st threshold Vth 1= 1 and the 2nd threshold Vth 2= 48 A printing dot train to four kinds, an isolated dot, 2 continuation dot, 3 continuation dot, and a mean value dot, a pattern part opium poppy, The number of an isolated dot, the count of generating of 2 continuation dot, the count of generating of 3 continuation dot, When counting of the number of an isolated dot tended to be carried out, (9) - (12) type tended to detect the toner consumption of each color based on those enumerated data and it asked for the weighting coefficient to each pattern, and the coefficient of the toner of each color by experiment, the result as shown in drawing 5 was obtained.

[0094] Since it is above, according to this toner consumption detection equipment, the consumption of the toner of each color can be calculated with a sufficient precision with an easy configuration, and, moreover, it can apply also to the equipment using the thing of a hybrid configuration, or the equipment which performs pulse modulation by other methods also at the equipment which uses Pulse Amplitude Modulation also for equipment using PWM as a pulse modulation method.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] While explaining the 1st toner consumption detection method concerning this invention, it is drawing for explaining actuation of the dot array pattern distinction circuit 4 of the toner consumption detection equipment 1 shown in drawing 2 .
[Drawing 2] It is drawing showing 1 operation gestalt of the toner consumption detection equipment which detects toner consumption by the 1st toner consumption detection method.
[Drawing 3] While explaining the 2nd toner consumption detection method concerning this invention, it is drawing for explaining actuation of the dot array pattern distinction circuit 12 of the toner consumption detection equipment 11 shown in drawing 4 ..
[Drawing 4] It is drawing showing 1 operation gestalt of the toner consumption detection equipment which detects toner consumption by the 2nd toner consumption detection method.
[Drawing 5] It is drawing showing an experimental result.
[Drawing 6] It is drawing showing other experimental results.
[Drawing 7] It is drawing showing the outline of the relation between the laser luminescence time amount when printing only the printing dot of a piece, and the amount of toners consumed by the printed dot.
[Description of Notations]
1 [— A dot array pattern distinction circuit 5 / — The 1st counter, 6 / — The 2nd counter, 7 / — The 3rd counter, 8 / — The 4th counter, 9 / — An arithmetic circuit, 10 / — A pulse modulation circuit, 11 / — Toner consumption detection equipment, 12 / — A dot array pattern distinction circuit, 13 / — The 2nd counter, 14 / — Arithmetic circuit] — Toner consumption detection equipment, 2 — The 1st comparison circuit, 3 — The 2nd comparison circuit, 4

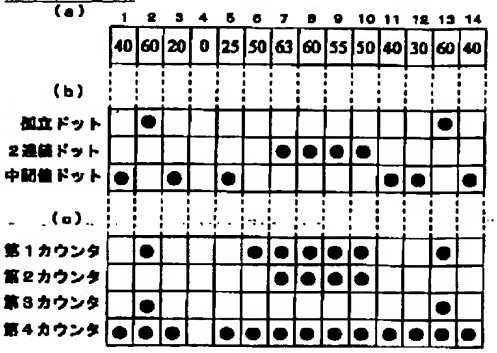
[Translation done.]

* NOTICES *

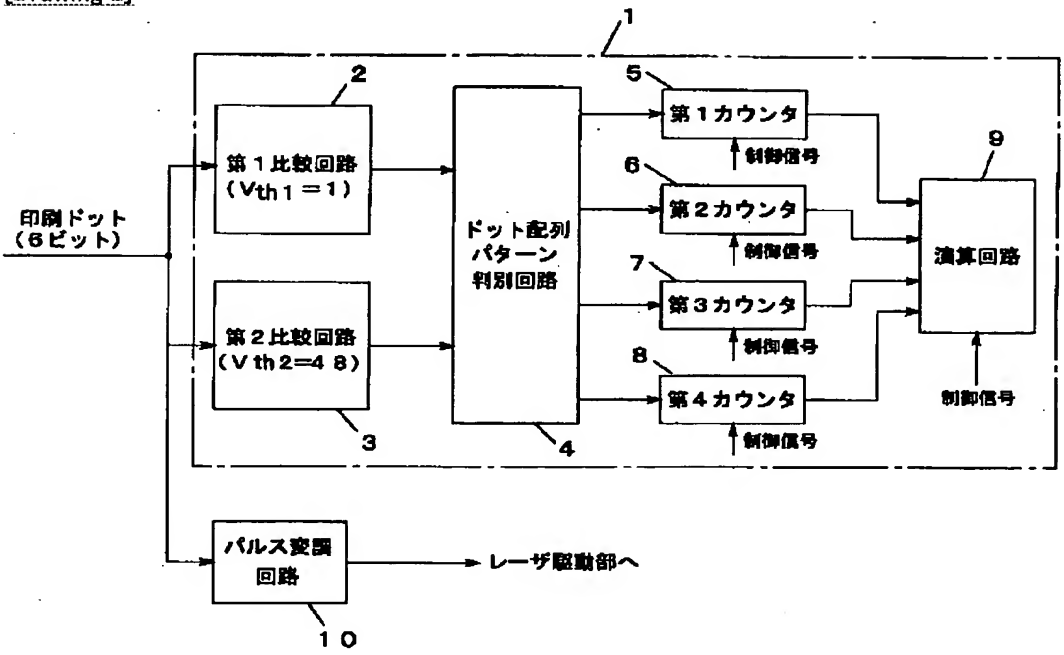
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

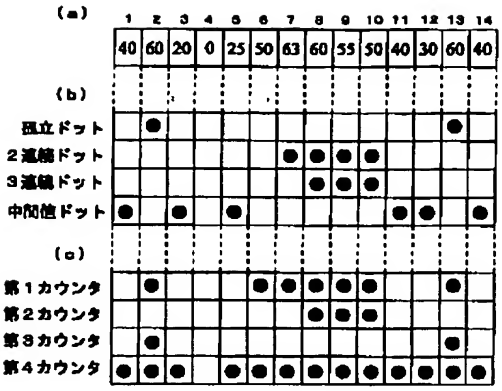
[Drawing 1]



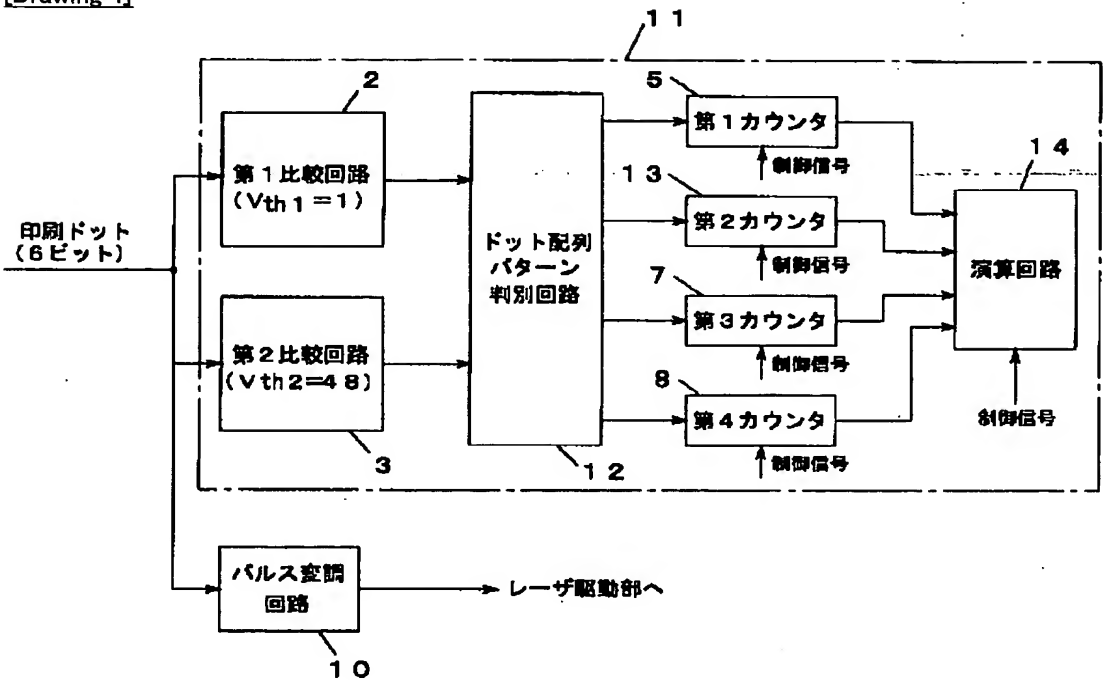
[Drawing 2]



[Drawing 3]

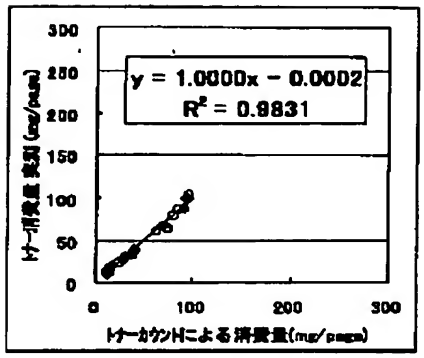


[Drawing 4]

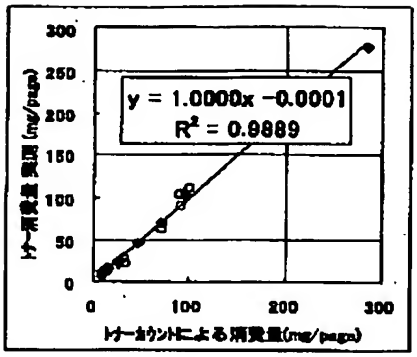


[Drawing 5]

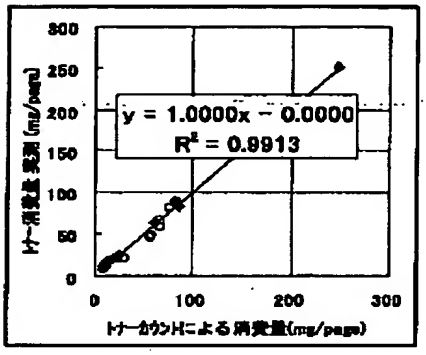
（a）　<Yトナー>



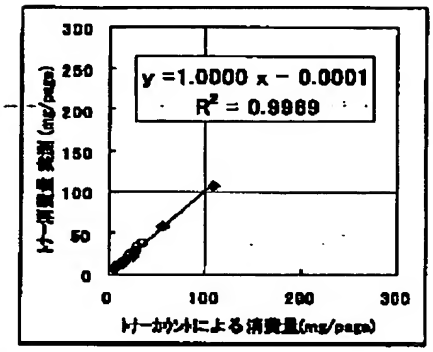
（b）　<Mトナー>



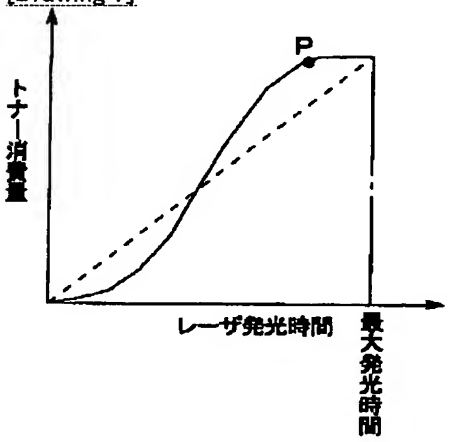
（c）　<Cトナー>



（d）　<Kトナー>

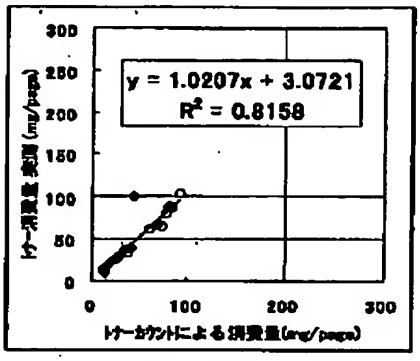


[Drawing 7]

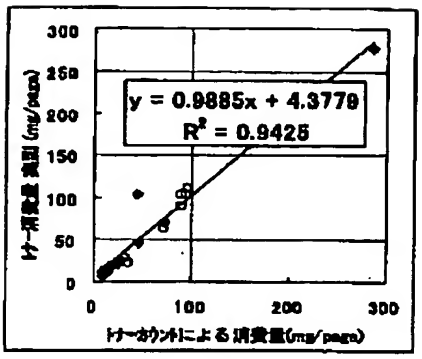


[Drawing 6]

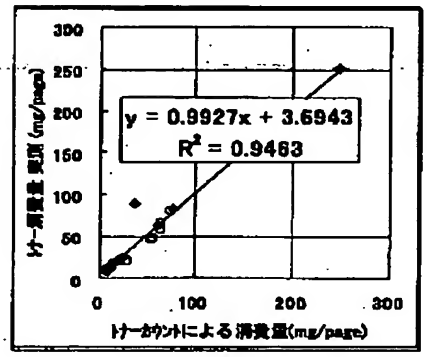
(a) <Yトナー>



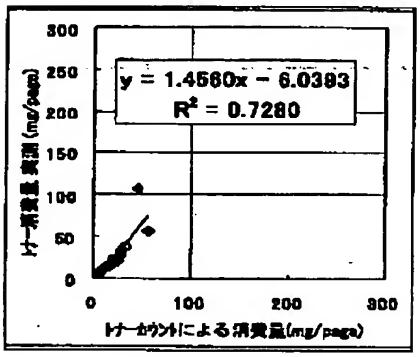
(b) <Mトナー>



(c) <Cトナー>



(d) <Kトナー>



[Translation done.]

(19)日本国特許庁（ＪＰ）　(12)公開特許公報（Ａ）　(11)特許出願公開番号
特開2002－174929
（Ｐ2002－174929Ａ）
(43)公開日　平成14年6月21日(2002.6.21)

(51)Int.Cl.'	識別記号	ＦＩ		テーマコード'(参考)
Ｇ０３Ｇ 15/00	３０３	Ｇ０３Ｇ 15/00	３０３	２Ｃ３６２
Ｂ４１Ｊ 2/44		15/01	１１３Ａ	２Ｈ０２７
Ｇ０３Ｇ 15/01	１１３	15/08	１１４	２Ｈ０３０
15/08	１１４	Ｂ４１Ｊ 3/00	Ｍ	２Ｈ０７７

審査請求　未請求　請求項の数４　ＯＬ　（全 16 頁）

(21)出願番号　特願2000－370962(Ｐ2000－370962)

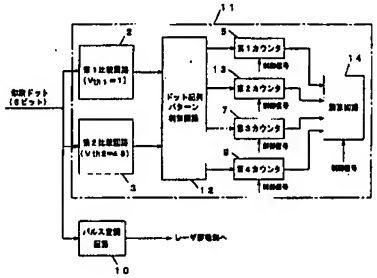
(22)出願日　平成12年12月６日(2000.12.6)

(71)出願人　000002369
セイコーエプソン株式会社
東京都新宿区西新宿２丁目４番１号
(72)発明者　杉田　隆俊
長野県諏訪市大和３丁目３番５号　セイコーエプソン株式会社内
(72)発明者　山田　喜子
長野県諏訪市大和３丁目３番５号　セイコーエプソン株式会社内
(74)代理人　100095980
弁理士　菅井　英雄　（外７名）

最終頁に続く

(54)【発明の名称】　トナー消費量検出方法及び装置

(57)【要約】
【課題】カラーレーザプリンタにおいて、簡単な構成で、精度よく各色のトナーの消費量を求める。
【解決手段】第１比較回路２は階調値が１以上の印刷ドットを出力し、第２比較回路３は階調値が４８以上の印刷ドットを出力する。ドット配列パターン判別回路１２は、階調値が４８以上の印刷ドットを検知する度毎に第１カウンタ５に１を出力し、３連続ドットが発生したことを検知する度毎に第２カウンタ１３に１を出力し、孤立ドットを検知する度毎に第３カウンタ７に１を出力し、階調値が１以上である印刷ドットを検知する度毎に第４カウンタ８に１を出力する。第１カウンタ５、第２カウンタ１３、第３カウンタ７、第４カウンタ８は、それぞれ、判別回路１２から１が出力されると、１だけカウントアップする動作を行う。演算回路１４は、第１～第４カウンタから受けた計数値に基づいて、所定の式によりトナー消費量を演算する。



【特許請求の範囲】
【請求項１】所定の単位の期間に、印刷する各色の画像について、印刷ドット列を孤立ドット、２連続ドット、中間値ドットの３つのパターンに分け、孤立ドットの個数、２連続ドットの発生回数、及び中間値ドットの個数を計数し、それらの計数値に基づいて記録用紙に記録された各色のトナーの消費量を求めることを特徴とするトナー消費量検出方法。
【請求項２】所定の単位の期間に、印刷する各色の画像について、印刷ドット列を孤立ドット、２連続ドット、３連続ドット、中間値ドットの４つのパターンに分け、孤立ドットの個数、２連続ドットの発生回数、３連続ドットの発生回数、及び中間値ドットの個数を計数し、それらの計数値に基づいて記録用紙に記録された各色のトナーの消費量を求めることを特徴とするトナー消費量検出方法。
【請求項３】第１の閾値と印刷ドットの値を比較する第１比較回路と、
第１の閾値より大きい第２の閾値と印刷ドットの値を比較する第２比較回路と、
第１比較回路及び第２比較回路の出力に基づいて、印刷ドット列を孤立ドット、２連続ドット、中間値ドットの３つのパターンに分け、孤立ドットの個数、２連続ドットの発生回数、及び中間値ドットの個数を計数し、それらの計数値に基づいて記録用紙に記録された各色のトナーの消費量を求める演算手段とを備えることを特徴とするトナー消費量検出装置。
【請求項４】第１の閾値と印刷ドットの値を比較する第１比較回路と、
第１の閾値より大きい第２の閾値と印刷ドットの値を比較する第２比較回路と、
第１比較回路及び第２比較回路の出力に基づいて、印刷ドット列を孤立ドット、２連続ドット、３連続ドット、中間値ドットの３つのパターンに分け、孤立ドットの個数、２連続ドットの発生回数、３連続ドットの発生回数、及び中間値ドットの個数を計数し、それらの計数値に基づいて記録用紙に記録された各色のトナーの消費量を求める演算手段とを備えることを特徴とするトナー消費量検出装置。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、印刷データにより変調された光ビームにより感光体に静電潜像を形成し、この静電潜像に記録材料であるカラートナーを静電的に吸着させて記録用紙に画像を形成するカラーレーザプリンタ等のカラー画像形成装置において、各色のトナーの消費量を簡単な構成で精度よく求める方法及び装置に関する。
【０００２】
【従来の技術及び発明が解決しようとする課題】カラーレーザプリンタ等のカラートナーを用いてカラー画像形成を行う装置においては、ユーザに対して、イエロー（Ｙ）、マゼンタ（Ｍ）、シアン（Ｃ）、ブラック（Ｋ）の各色のトナーの消費量あるいは残量を示すことが要望されている。そのためには、カラー画像形成を行う度毎に各色のトナーがどれだけ消費されたかを検出する必要があるが、近年のカラー画像形成装置においては、記録用紙に実際に印刷される一つ一つのドット（これを印刷ドットと称する）は多階調、即ち１印刷ドットは複数ビット構成となされており、しかも、印刷ドットの値と、消費されるトナー量との関係は非線形であるので、カラー画像形成を行ったときに消費されるＣ、Ｍ、Ｙ、Ｋの各色のトナー消費量を検出することは非常に難しいとされている。
【０００３】印刷ドットの値とトナー消費量の関係が非線形であることはよく知られているが、例えば次のようなことがある。現在のカラー画像形成装置では、パルス変調方式として、印刷ドットの値に応じた幅を有するパルスを生成してレーザ光の発光時間を制御するパルス幅変調（ＰＷＭ）方式が採用されているのが一般的であるが、一個の印刷ドットだけを印刷したときのレーザ発光時間、即ちＰＷＭ回路から出力されたパルスの幅と、印刷されたドットに消費されるトナー量との関係は概略図７の実線で示すようになることが知られている。レーザ発光時間は印刷ドットの値に応じたものであるから、以上のことは印刷ドットの値とトナー消費量との関係は非線形であることを意味しているということができる。
【０００４】しかし、図７の実線で示す関係は常に成り立つのではない。例えば、ある値の印刷ドットを１つだけ単独で印刷したときのトナー消費量がＸｍｇであるとしても、当該印刷ドットの前後の隣接する印刷ドットの値によっては、当該印刷ドットを印刷するに要するトナー量はＸｍｇとは異なってくるのである。このように、印刷ドットを単独で１個だけ印刷する場合にも印刷ドットの値と消費トナー量の関係は非線形であり、さらに、その前後の隣接する印刷ドットの値によっても当該印刷ドットを印刷する場合に消費されるトナー量は変化するという、非常に複雑な現象があるのである。
【０００５】本発明は以上のような事情に鑑みてなされたもので、１印刷ドットが複数ビット構成であるカラー画像形成装置においても、簡単な構成で、しかも精度よく、Ｃ、Ｍ、Ｙ、Ｋの各色のトナーの消費量を検出することができるトナー消費量検出方法及び装置を提供することを目的とするものである。
【０００６】
【課題を解決するための手段】上記の目的を達成するために、本発明に係る第１のトナー消費量検出方法は、請求項１記載のように、所定の単位の期間に、印刷する各色の画像について、印刷ドット列を孤立ドット、２連続ドット、中間値ドットの３つのパターンに分け、孤立ド

ットの個数、２連続ドットの発生回数、及び中間値ドットの個数を計数し、それらの計数値に基づいて記録用紙に記録された各色のトナーの消費量を求めることを特徴とする。また、本発明に係る第２のトナー消費量検出方法は、請求項２記載のように、所定の単位の期間に、印刷する各色の画像について、印刷ドット列を孤立ドット、２連続ドット、３連続ドット、中間値ドットの４つのパターンに分け、孤立ドットの個数、２連続ドットの発生回数、３連続ドットの発生回数、及び中間値ドットの個数を計数し、それらの計数値に基づいて記録用紙に記録された各色のトナーの消費量を求めることを特徴とする。本発明に係る第１のトナー消費量検出装置は、請求項３記載のように、第１の閾値と印刷ドットの値を比較する第１比較回路と、第１の閾値より大きい第２の閾値と印刷ドットの値を比較する第２比較回路と、第１比較回路及び第２比較回路の出力に基づいて、印刷ドット列を孤立ドット、２連続ドット、中間値ドットの３つのパターンに分け、孤立ドットの個数、２連続ドットの発生回数、及び中間値ドットの個数を計数し、それらの計数値に基づいて記録用紙に記録された各色のトナーの消費量を求める演算手段とを備えることを特徴とする。また、本発明に係る第２のトナー消費量検出装置は、請求項４記載のように、第１の閾値と印刷ドットの値を比較する第１比較回路と、第１の閾値より大きい第２の閾値と印刷ドットの値を比較する第２比較回路と、第１比較回路及び第２比較回路の出力に基づいて、印刷ドット列を孤立ドット、２連続ドット、３連続ドット、中間値ドットの３つのパターンに分け、孤立ドットの個数、２連続ドットの発生回数、３連続ドットの発生回数、及び中間値ドットの個数を計数し、それらの計数値に基づいて記録用紙に記録された各色のトナーの消費量を求める演算手段とを備えることを特徴とする。

【０００７】

【発明の実施の形態】以下、図面を参照しつつ発明の実施の形態について説明する。ところで、上述したように印刷ドットの値と消費トナー量との関係は非線形であるので、印刷ドットの値に着目してトナー消費量を検出しようとすることは難しいものとなる。そこで、本発明者は、種々の実験の結果、各々の印刷ドットの値それ自体に着目するのではなく、入力する印刷ドット列がどのような値の印刷ドットの配列となっているか、その配列のパターンに着目してトナー消費量を検出する２つの方法を見出したのである。第１の方法は基本的な方法であり、第２の方法は第１の方法の改良である。なお、実験結果については後に示す。

【０００８】［第１のトナー消費量検出方法］まず、第１の方法について説明する。この方法においては、印刷ドットの値に２つの閾値Ｖth1 、Ｖth2 を定めて印刷ドット列の配列パターンを３種類にパターン分けする。第１の閾値Ｖth1 は印刷ドットがトナーを消費するものであるか否かを判別するためのものであり、印刷ドットの階調値でＶth1＝１とする。第２の閾値Ｖth2 は階調値がある程度以上であるか否かを判別するためのもので、印刷ドットのビット構成によって適宜定めることができるが、１印刷ドットが６ビット構成の場合には、印刷ドットの階調値でＶth2＝４８程度とするのがよいことが実験によって確認されている。このことについては後に比較例を示す。実は、Ｖth2＝４８というのは、１印刷ドットが６ビット構成の場合、図７においてＰで示すように、レーザ発光時間とトナー消費量の関係を示すグラフにおけるレーザ発光時間が長い方の変曲点近傍の階調値に対応していることが確認されている。

【０００９】そして、印刷ドット列の配列のパターンを次の３種類にパターン分けする。

①孤立ドット…階調値が第２の閾値以上である印刷ドットで、且つその前後の印刷ドットの階調値が共に第２の閾値未満である印刷ドット。このような印刷ドットを孤立ドットと称する。

②２連続ドット…階調値が第２の閾値以上である印刷ドットが２つ連続する場合。この場合を２連続ドットと称する。

③中間値ドット…階調値が第１の閾値以上で第２の閾値未満である印刷ドット。このような印刷ドットを中間値ドットと定義する。

【００１０】このようにパターン分けするのは概略次のようである。図７からも容易に理解できるように、値が第２の閾値以上である印刷ドットと、中間値ドットでは明らかにトナー消費量が異なる。そこで、まず値が第２の閾値以上のものと、それ未満の中間値ドットに分けることの妥当性は明らかである。次に孤立ドットと２連続ドットを区別することについては次のようである。例えば、ある色について、最大階調の印刷ドットを１つだけ単独で印刷したときのトナー消費量がＸｍｇであることが分かっているとする。このとき、最大階調の印刷ドットを２ドット連続して印刷したとすると、このときの当該色のトナーの消費量は、Ｘｍｇの２倍ではなく、それより若干多くなることが知られている。このような事情により、値が第２の閾値以上の印刷ドットであっても、孤立している場合と２つ連続している場合とをパターン分けするのである。

【００１１】そして、１頁単位あるいはジョブ単位等の適宜な単位の期間に、印刷する画像のＣ、Ｍ、Ｙ、Ｋの各色の画像毎に、孤立ドットの個数、２連続ドットの発生回数、及び中間値ドットの個数を計数し、その３つの計数値のそれぞれに対して、各パターンに対する重み付けの係数を乗算してそれら３つの値を加算し、その加算値にトナーの色に応じた係数を乗算することにより記録用紙に記録された各色のトナーの消費量を求め、それにオフセット量を加えて、そのときに消費された各色の全トナー量を求めるのである。

【００１２】ここで、オフセット量というのは、レーザ光による露光時間とは無関係に消費されるトナー量であり、カラー画像形成装置毎に特有な固有値である。即ち、真っ白の画像を印刷した場合にも感光体をクリーニングすると、いくらかのトナーが排出されることが知られている。これがオフセット量である。このオフセット量は色によって異なるので、Ｃ、Ｍ、Ｙ、Ｋの各色のトナーについてそれぞれオフセット量を測定しておく。

【００１３】具体的には次のようである。いま、１頁単位に各色のトナー消費量を検出するものとする。また、カラー画像形成のプロセスはＣ、Ｍ、Ｙ、Ｋの順序に行われるものとする。

【００１４】この場合、まず、順次入力するＣ色の画像の印刷ドットについて、孤立ドットの個数、２連続ドットの発生回数、及び中間値ドットの個数を計数する。例えば、いま、Ｃ色の画像の印刷ドット列が図１（ａ）に示すようであるとする。図１（ａ）においては１印刷ドットは６ビット構成で６４階調であるとし、第１の閾値Ｖth1＝1、第２の閾値Ｖth2＝４８としている。そして、矩形は一つ一つの印刷ドットを示し、矩形の中の数値はそれぞれの印刷ドットの階調値を示している。また、図１（ａ）では便宜的に印刷ドットに対して１～１４の番号を付している。

【００１５】さて、図１（ａ）において、２番目の印刷ドットの階調値は６０であるので第２の閾値以上であり、その前後の印刷ドットの階調値は４０と２０で共に第２の閾値未満であるので、２番目の印刷ドットは孤立ドットである。１３番目の印刷ドットも同様に孤立ドットである。図１（ｂ）の孤立ドットの欄の黒丸はこのことを示している。

【００１６】また、６番目の印刷ドットの階調値は第２の閾値以上であり、次の７番目の印刷ドットの階調値も第２の閾値以上である。従って、階調値が第２の閾値以上の印刷ドットが６番目、７番目と連続しているので、ここで２連続ドットが１回発生している。図１（ｂ）の２連続ドットの欄の７番目の印刷ドットの箇所に黒丸が付いているのはこのことを示している。同様に、７番目と８番目の印刷ドットの階調値は共に第２の閾値以上であるので、ここでも２連続ドットが１回発生している。図１（ｂ）の２連続ドットの欄の８番目の印刷ドットの箇所に黒丸が付いているのはこのことを示している。以下同様である。また、中間値ドットは上記の定義により、図１（ｂ）の中間値ドットの欄の黒丸で示すようになる。従って、図１（ａ）の場合、孤立ドットの個数の計数値は２、２連続ドットの発生回数の計数値は４、中間値ドットの個数の計数値は６となる。

【００１７】そして、それら３つの計数値のそれぞれに、各パターンに対する重み付け係数を乗算して、それらの３つの値を加算する。そして、更にその加算値にＣ色のトナーの係数を乗算し、更にその乗算値にオフセット量を加えて、そのときに消費されたＣ色のトナー量を求める。従って、当該１頁でのＣ色トナーの消費量は、孤立ドットのパターンに対する重み付け係数をｋ１ 、２連続ドットのパターンに対する重み付け係数をｋ２ 、及び中間値ドットのパターンに対する重み付け係数をｋ３ とし、Ｃ色のトナーの係数をＫｃ として

Ｃ色トナー消費量＝Ｋｃ ×｛ｋ１ ×（孤立ドットの個数の計数値）
＋ｋ２ ×（２連続ドットの発生回数の計数値）
＋ｋ３ ×（中間値ドットの個数の計数値）｝
＋Ｃ色トナーのオフセット量　…(1)

となる。

※計数値にそれぞれ所定の係数を乗算し、それら３つの値を加算し、更にその加算値にオフセット量を加えて、そのときに消費されたＭ色のトナー量を求める。従って、当該１頁でのＭ色トナーの消費量は、Ｍ色のトナーの係数をＫｍ すると

Ｍ色トナー消費量＝Ｋｍ ×｛ｋ１ ×（孤立ドットの個数の計数値）
＋ｋ２ ×（２連続ドットの発生回数の計数値）
＋ｋ３ ×（中間値ドットの個数の計数値）｝
＋Ｍ色トナーのオフセット量　…(2)

となる。

該１頁でのＹ色トナーの消費量、Ｋ色トナーの消費量は、Ｙ色のトナーの係数をＫｙ 、Ｋ色のトナーの係数をＫｋ として、それぞれ

【００１９】以下、Ｙ色の画像の印刷ドット、及びＫ色の画像の印刷ドットについても同様である。従って、当

Ｙ色トナー消費量＝Ｋｙ ×｛ｋ１ ×（孤立ドットの個数の計数値）
＋ｋ２ ×（２連続ドットの発生回数の計数値）
＋ｋ３ ×（中間値ドットの個数の計数値）｝
＋Ｙ色トナーのオフセット量　…(3)

Ｋ色トナー消費量＝Ｋｋ ×｛ｋ１ ×（孤立ドットの個数の計数値）
＋ｋ２ ×（２連続ドットの発生回数の計数値）

＋ｋ３ ×（中間値ドットの個数の計数値）］
＋Ｋ色トナーのオフセット量 …(4)

となる。

【００２０】なお、上記の各パターンに対する重み付け係数ｋ１、ｋ２、ｋ３、及び各色のトナーの係数Ｋｙ、Ｋｍ、Ｋｃ、Ｋｋの値は、種々の画像について印刷を行い、そのときに記録用紙に印刷された各色のトナー量を実測し、その実測されたトナー量と、そのときの印刷した画像の各色の印刷ドット列の孤立ドットの個数、２連続ドットが発生する回数、中間値ドットの個数との関係等に基づいて定めればよい。

【００２１】上記の(1)～(4)式では３つのパターンに対する重み付け係数ｋ１、ｋ２、ｋ３の値は同じ値を用いるものとしているが、トナーの色によって特性が異なるので、トナーの色によって、孤立ドットのパターンに対する重み付け係数、２連続ドットのパターンに対する重み付け係数、及び中間値ドットのパターンに対する重み付け係数は異ならせてもよいものである。また、上記の説明では第２の閾値はＣ、Ｍ、Ｙ、Ｋについて全て同じであるとしたが、色によって異ならせてもよいものである。

【００２２】このようにして求めた各色のトナーの消費量は種々に用いることができる。例えば、当該カラー画像形成装置がパソコンに接続されている場合には、求めたトナー消費量をパソコンに渡して、パソコン側でトナー消費量を積算して記憶しておき、印刷時に棒グラフとして表示するようにすることができる。

【００２３】以上のようであるので、このトナー消費量検出方法では、印刷画像の各色の印刷ドット列のパターンを孤立ドット、２連続ドット、中間値ドットの３種類に分け、孤立ドットの個数、２連続ドットの発生回数、中間値ドットの個数を計数し、それら３つの計数値にそれぞれのパターンに対する重み付け係数を乗算して加算し、その加算値にトナーの色に応じた係数を乗算し、その乗算値にオフセット量を加算するという処理を行えばよいので、後述するように簡単な構成で実現することができる。また、このトナー消費量検出方法は、印刷ドット列に基づいてトナー消費量の検出を行うので、レーザ光を駆動するためのパルスを生成するパルス変調方式に因らず、ＰＷＭを用いる装置にも、パルス振幅変調（ＰＡＭ）方式を用いる装置にも、あるいはＰＷＭとＰＡＭを組み合わせたハイブリッド構成の装置にも適用することができる。

【００２４】［第１のトナー消費量検出方法を採用したトナー消費量検出装置］次に、上述したトナー消費量検出方法によりトナー消費量の検出を行うトナー消費量検出装置の一実施形態を説明する。なお、ここでは１印刷ドットは６ビット構成であるとする。

【００２５】図２は、トナー消費量検出装置をカラーレーザプリンタに適用した場合の一実施形態の部分ブロック図を示す図であり、１はトナー消費量検出装置、２は第１比較回路、３は第２比較回路、４はドット配列パターン判別回路（以下、単に判別回路と称す）、５は第１カウンタ、６は第２カウンタ、７は第３カウンタ、８は第４カウンタ、９は演算回路、１０はパルス変調回路を示す。なお、ここではカラーレーザプリンタは、１つの感光体の周囲にＣ、Ｍ、Ｙ、Ｋの４色の現像器が配置されたタイプのものであるとする。このタイプのカラーレーザプリンタにおいては、１つのレーザ光でＣ、Ｍ、Ｙ、Ｋの４色の静電潜像を１つの感光体に形成することは周知である。また、このタイプのカラーレーザプリンタの全体の構成は周知であり、しかも本発明の本質ではないので、図２では感光体や現像器等については図示を省略している。

【００２６】以下、図２に示す各部について説明する。第１比較回路２は、入力する印刷ドットの値と第１の閾値Ｖｔｈ１とを比較し、第１の閾値以上の値を有する印刷ドットを判別回路４に出力するものであり、この第１の閾値Ｖｔｈ１は階調値で１である。

【００２７】第２比較回路３は、入力する印刷ドットの値と第２の閾値Ｖｔｈ２とを比較し、第２の閾値以上の値を有する印刷ドットを判別回路４に出力するものであり、ここでは第２の閾値Ｖｔｈ２は階調値で４８とする。

【００２８】判別回路４は、第１比較回路２と第２比較回路３とから順次入力される印刷ドットの値の列に基づいて、印刷ドットの値が第１の閾値以上である場合、印刷ドットの値が第２の閾値以上である場合、２連続ドットが発生している場合、孤立ドットである場合の４つの場合を判別するものであり、階調値が第２の閾値以上の印刷ドットを検知する度毎に第１カウンタ５に１を出力し、２連続ドットが発生したことを検知する度毎に第２カウンタ６に１を出力し、孤立ドットを検知する度毎に第３カウンタ７に１を出力し、階調値が第１の閾値以上である印刷ドットを検知する度毎に第４カウンタ８に１を出力する。従って、この場合には、階調値が第２の閾値である４８以上の印刷ドットについては、少なくとも、第１カウンタ５と第４カウンタ８の両方に１が出力されることになる。

【００２９】第１カウンタ５、第２カウンタ６、第３カウンタ７、第４カウンタ８は、それぞれ、判別回路４から１が出力されると、１だけカウントアップする動作を行う。なお、これら４つのカウンタには、それぞれ、図示しないカラー画像形成の処理を司る制御部から制御信号が通知される。この制御信号には、印刷ドットの転送開始を通知するスタート信号と、印刷ドットの転送終了を通知するエンド信号がある。そして、これら４つのカウンタは、スタート信号を受けると、判別回路４からの出力の計数を開始し、エンド信号受けると計数値を演算

回路９に渡して計数値をクリアする。従って、例えば図１（ａ）に示すような印刷ドットの配列があるとすると、判別回路４は、第１カウンタ５に対しては図１（ｃ）の第１カウンタの欄の黒丸で示すように、２番目、６～１０番目、１３番目の印刷ドットのときにそれぞれ１を出力することになり、従って図１（ａ）に示す印刷ドット列の期間における第１カウンタ５での計数値は７となる。第２カウンタ６～第４カウンタ８についても同様である。

【００３０】演算回路９には、図示しないカラー画像形成の処理を司る制御部から制御信号が通知される。この制御信号には、現在行われているプロセスがどの色のものであるかを示す色信号、印刷ドットの転送開始を通知するスタート信号、及び印刷ドットの転送終了を通知するエンド信号がある。従って、演算回路９は第１カウンタ５～第４カウンタ８から計数値を受けるが、演算回路９は制御部からの色信号により、各カウンタ５～８から受け取った計数値が、どの色の画像についてのものであるかを認識している。

【００３１】そして、演算回路９は、第１カウンタ５～第４カウンタ８から受けた計数値に基づいて、孤立ドットの個数の計数値、２連続ドットの発生回数の計数値、中間値ドットの個数の計数値を求める。孤立ドットの個数の計数値は第３カウンタ７の計数値そのものである。２連続ドットの発生回数の計数値は第２カウンタ６の計数値そのものである。また、中間値ドットの個数の計数値は、第４カウンタ８の計数値から第１カウンタ５の計数値を引いた値で求めることができる。

【００３２】そして、演算回路９は、孤立ドットの個数の計数値、２連続ドットの発生回数の計数値、中間値ドットの個数の計数値の計数値に、それぞれのパターンに対する重み付け係数ｋ１、ｋ２、ｋ３を乗算して、これら３つの値を加算し、更にその加算値にトナーの色に応じた係数を乗算し、更にそれにトナーの色に応じたオフセット量を加算して、今回のプリントにおける当該色のトナー消費量を求める。なお、これら３つのパターンに対する重み付け係数ｋ１、ｋ２、ｋ３の値、各色のトナーの係数Ｋｙ、Ｋｍ、Ｋｃ、Ｋｋの値、及び各色のオフセット量は予め演算回路９に設定されている。

【００３３】パルス変調回路１０は印刷ドットに基づいてレーザ光を駆動するパルスを生成するものであり、ＰＷＭを用いるものであってもよく、ＰＡＭを用いるものであってもよく、あるいはそれらを組み合わせたハイブリッド構成のものであってもよい。＊

Ｃ色トナー消費量＝Ｋｃ ×（ｋ１ ×（第３カウンタの計数値）
＋ｋ２ ×（第２カウンタの計数値）
＋ｋ３ ×（第４カウンタの計数値－第１カウンタの計数値））
＋Ｃ色トナーのオフセット量 …(5)

このようにしてＣの画像形成のプロセスが終了すると、次に、Ｍの画像形成のプロセスが開始されるが、このとき第１カウンタ５～第４カウンタ８には制御部からスタート信号が通知され、演算回路９には制御部から、Ｃの

＊【００３４】以下、動作を説明するが、ここでは、カラー画像形成のプロセスはＣ、Ｍ、Ｙ、Ｋの順序に行われるものとする。まず、Ｃのカラー画像形成のプロセスが行われるが、このとき第１カウンタ５～第４カウンタ８には制御部からスタート信号が通知され、演算回路９には制御部から、Ｃのカラー画像形成であることを示す色信号とスタート信号が通知される。

【００３５】そして、Ｃの画像の印刷ドットの転送が開始され、この印刷ドットは、第１比較回路２、第２比較回路３、及びパルス変調回路１０に入力される。パルス変調回路１０では一つ一つの印刷ドットの値に基づいてパルス変調が行われ、生成されたパルスはレーザ駆動部（図２には図示せず）に供給される。

【００３６】また、第１比較回路２は、入力する印刷ドットの値が第１の閾値Ｖｔｈ１以上の場合には、その印刷ドットの値を判別回路４に出力し、第２比較回路３は、入力する印刷ドットの値が第２の閾値Ｖｔｈ２以上である場合には、この印刷ドットの値を判別回路４に出力する動作を行う。

【００３７】そして、判別回路４は、第１比較回路２と第２比較回路３とから順次供給される印刷ドットの値の列に基づいて、印刷ドットの値が第１の閾値以上である場合、印刷ドットの値が第２の閾値以上である場合、２連続ドットが発生している場合、孤立ドットである場合の４つの場合を判別するものであり、階調値が第２の閾値以上の印刷ドットを検知する度毎に第１カウンタ５に１を出力し、２連続ドットが発生したことを検知する度毎に第２カウンタ６に１を出力し、孤立ドットを検知する度毎に第３カウンタ７に１を出力し、階調値が第１の閾値以上である印刷ドットを検知する度毎に第４カウンタ８に１を出力する動作を行う。

【００３８】第１カウンタ５～第４カウンタ８は、スタート信号を受けてからエンド信号を受けるまでの間、判別回路４から１が出力される度毎にカウントアップする動作を繰り返す。そして、第１カウンタ５～第４カウンタ８は、エンド信号を受けると、そのときの計数値を演算回路９に渡して計数値をクリアし、次の計数動作の待機を行う。

【００３９】演算回路９は、第１カウンタ５～第４カウンタ８から計数値を受けると、当該計数値はＣの画像の印刷ドットについての計数値であることを認識しているから、次の式により、このときのＣ色トナーの消費量を求める。

11

カラー画像形成であることを示す色信号とスタート信号が通知される。

【００４０】そして、Ｍの画像の印刷ドットの転送が開始され、この印刷ドットは、第１比較回路２、第２比較回路３、及びパルス変調回路１０に入力される。パルス変調回路１０では一つ一つの印刷ドットの値に基づいてパルス変調が行われ、生成されたパルスはレーザ駆動部に供給される。

【００４１】また、第１比較回路２は、入力する印刷ドットの値が第１の閾値Ｖth1 以上の場合には、その印刷ドットの値を判別回路４に出力し、第２比較回路３は、入力する印刷ドットの値が第２の閾値Ｖth2 以上である場合には、この印刷ドットの値を判別回路４に出力する動作を行う。

【００４２】そして、判別回路４は、第１比較回路２と第２比較回路３とから順次供給される印刷ドットの値の列に基づいて、印刷ドットの値が第１の閾値以上である場合、印刷ドットの値が第２の閾値以上である場合、２連続ドットが発生している場合、孤立ドットである場合＊

12

＊の４つの場合を判別するものであり、階調値が第２の閾値以上の印刷ドットを検知する度毎に第１カウンタ５に１を出力し、２連続ドットが発生したことを検知する度毎に第２カウンタ６に１を出力し、孤立ドットを検知する度毎に第３カウンタ７に１を出力し、階調値が第１の閾値以上である印刷ドットを検知する度毎に第４カウンタ８に１を出力する動作を行う。

【００４３】第１カウンタ５～第４カウンタ８は、スタート信号を受けてからエンド信号を受けるまでの間、判別回路４から１が出力される度毎にカウントアップする動作を繰り返す。そして、第１カウンタ５～第４カウンタ８は、エンド信号を受けると、そのときの計数値を演算回路９に渡して計数値をクリアし、次の計数動作の待機を行う。

【００４４】演算回路９は、第１カウンタ５～第４カウンタ８から計数値を受けると、当該計数値はＭの画像の印刷ドットについての計数値であることを認識しているから、次の式により、このときのＭ色トナーの消費量を求める。

Ｍ色トナー消費量＝Km ×｛k1 ×（第３カウンタの計数値）
＋k2 ×（第２カウンタの計数値）
＋k3 ×（第４カウンタの計数値－第１カウンタの計数値）｝
＋Ｍ色トナーのオフセット量　…(6)

【００４５】次に、Ｙの画像形成のプロセスが行われ、続いてＫの画像形成のプロセスが行われるが、これらの画像形成プロセス時にも同様にして、Ｙ色のトナー消費量、Ｋ色のトナー消費量が求められる。このときのＹ色※

※トナーの消費量、及びＫ色トナーの消費量はそれぞれ次のようである。

【００４６】

Ｙ色トナー消費量＝Ky ×｛k1 ×（第３カウンタの計数値）
＋k2 ×（第２カウンタの計数値）
＋k3 ×（第４カウンタの計数値－第１カウンタの計数値）｝
＋Ｙ色トナーのオフセット量　…(7)

Ｋ色トナー消費量＝Kk ×｛k1 ×（第３カウンタの計数値）
＋k2 ×（第２カウンタの計数値）
＋k3 ×（第４カウンタの計数値－第１カウンタの計数値）｝
＋Ｋ色トナーのオフセット量　…(8)

【００４７】なお、以上の例では、１つのレーザ光でＣ、Ｍ、Ｙ、Ｋの４色の静電潜像を１つの感光体に形成するタイプのカラーレーザプリンタに適用した場合について説明したので、各色のトナー消費量の演算は、１つの色画像の形成プロセス毎に行っているが、感光体と現像器のセットを４つ備える、いわゆるタンデムタイプのものに適用する場合には、Ｃ、Ｍ、Ｙ、Ｋの４つの画像形成プロセスの系統にそれぞれこのトナー消費量検出装置を設ければよいので、１回のプリント単位にトナー消費量を演算するようにすることも勿論可能であるが、ジョブ単位、あるいは１日単位等の適宜な単位でトナー消費量の演算を行うことも可能である。その場合には、４つのカウンタ及び演算回路９に通知する制御信号の形態を、トナー消費量の演算を行う単位に応じて適宜変更する必要があることは当然である。

【００４８】上記の説明では３つのパターンに対する重み付け係数ｋ１、ｋ２、ｋ３ の値は同じ値を用いるものとしているが、トナーの色によって特性が異なるので、トナーの色によって、孤立ドットのパターンに対する重み付け係数、２連続ドットのパターンに対する重み付け係数、及び中間値ドットのパターンに対する重み付け係数は異ならせてもよいものである。

【００４９】演算回路９で求めた各色のトナーの消費量のデータは、トナー消費量あるいはトナー残量の表示を行う処理を司る手段に与えればよい。これにより、当該カラーレーザプリンタにプリントする画像データを与えるパソコンの印刷画面において、各色のトナーの消費量あるいは残量を棒グラフ等の適宜なグラフによって表示することが可能であり、また、当該プリンタ自体に適宜な表示機能を有しているものであれば、その表示機能を

13

用いて各色のトナーの消費量あるいは残量を表示することが可能である。

【００５０】以上のようであるので、このトナー消費量検出装置によれば、簡単な構成で各色のトナー消費量を求めることができ、しかも、どのようなパルス変調方式を用いるものにも適用することが可能である。

【００５１】［第２のトナー消費量検出方法］次に、第２のトナー量検出方法について説明する。なお、孤立ドット、２連続ドット、中間値ドット、第１の閾値、第２の閾値については上述したと同じである。

【００５２】この第２の方法は、上述した第１の方法の改良であり、第１の方法では印刷ドット列の配列のパターンを、孤立ドット、２連続ドット、中間値ドットの３種類に分類し、孤立ドットの個数の計数値、２連続ドットの発生回数の計数値、及び中間値ドットの個数の計数値の３つの計数値に基づいて各色のトナーの消費量を検出したのであるが、この第２の方法では、上記の３種類のパターンに加えて、３連続ドットをも判別するようにしている。ここで、３連続ドットとは、階調値が第２の閾値以上である印刷ドットが３つ連続する場合をいうものとする。

【００５３】２連続ドットに加えて、３連続ドットをも判別するのは、例えば最大階調の印刷ドットが２つ連続している場合と、３つ連続している場合とでは、後者のトナー消費量は、前者のトナー消費量の３／２ではなく、それより若干多くなるという現象があるので、２連続ドットと３連続ドットとを区別することによって、より精度よくトナー消費量の検出を行うことができると考えられるからである。

【００５４】具体的には次のようである。いま、１頁単位に各色のトナー消費量を検出するものとする。また、カラー画像形成のプロセスはＣ、Ｍ、Ｙ、Ｋの順序に行われるものとする。

【００５５】この場合、まず、順次入力するＣ色の画像の印刷ドットについて、孤立ドットの個数、２連続ドッ＊

14

＊トの発生回数、３連続ドットの発生回数、及び中間値ドットの個数を計数する。例えば、いま、Ｃ色の画像の印刷ドット列が図３（ａ）に示すようであるとする。なお、図３（ａ）は図１（ａ）と同じである。ここでも１印刷ドットは６ビット構成であり、第１の閾値Ｖth1＝１、第２の閾値Ｖth2＝４８とする。

【００５６】孤立ドット、２連続ドット、中間値ドットについては第１の方法で説明したと同じである。３連続ドットについては次のようである。６番目の印刷ドットの階調値は第２の閾値以上であり、次の７番目及び８番目の印刷ドットの階調値も共に第２の閾値以上である。従って、階調値が第２の閾値以上の印刷ドットが６番目、７番目、８番目と連続しているので、ここで３連続ドットが１回発生している。図３（ｂ）の３連続ドットの欄の８番目の印刷ドットの箇所に黒丸が付いているのはこのことを示している。同様に、７番目と８番目と９番目の印刷ドットの階調値は何れも第２の閾値以上であるので、ここでも３連続ドットが１回発生している。図３（ｂ）の３連続ドットの欄の９番目の印刷ドットの箇所に黒丸が付いているのはこのことを示している。以下同様である。従って、図３（ａ）の場合、孤立ドットの個数の計数値は２、２連続ドットの発生回数の計数値は４、３連続ドットの発生回数の計数値は３、中間値ドットの個数の計数値は６となる。

【００５７】そして、それら４つの計数値にそれぞれ各パターンに対する重み付け係数を乗算して、それらの４つの値を加算する。そして、更にその加算値にＣ色のトナーの係数を乗算し、更にその乗算値にオフセット量を加えて、そのときに消費されたＣ色のトナー量を求める。従って、当該１頁でのＣ色トナーの消費量は、孤立ドットのパターンに対する重み付け係数をｋ１、２連続ドットのパターンに対する重み付け係数をｋ２、３連続ドットのパターンに対する重み付け係数をｋ３、中間値ドットのパターンに対する重み付け係数をｋ４とし、Ｃ色のトナーの係数をKc として

Ｃ色トナー消費量＝Kc ×｛k1 ×（孤立ドットの個数の計数値）
＋k2 ×（２連続ドットの発生回数の計数値）
＋k3 ×（３連続ドットの発生回数の計数値）
＋k4 ×（中間値ドットの個数の計数値）｝
＋Ｃ色トナーのオフセット量　…(9)

となる。

【００５８】次に、Ｍ色の画像の印刷ドットが順次入力されるが、Ｍ色の画像の印刷ドットに対しても、同様に、孤立ドットの個数、２連続ドットの発生回数、３連続ドットの発生回数、及び中間値ドットの個数を計数する。そして、それら４つの計数値にそれぞれ各パターン

に対する重み付け係数を乗算して、それらの４つの値を加算する。そして、更にその加算値にＭ色のトナーの係数を乗算し、更にその乗算値にオフセット量を加えて、そのときに消費されたＭ色のトナー量を求める。従って、当該１頁でのＣ色トナーの消費量は、Ｍ色のトナーの係数をKm として

Ｍ色トナー消費量＝Km ×｛k1 ×（孤立ドットの個数の計数値）
＋k2 ×（２連続ドットの発生回数の計数値）
＋k3 ×（３連続ドットの発生回数の計数値）
＋k4 ×（中間値ドットの個数の計数値）｝

＋Ｍ色トナーのオフセット量 …(10)

となる。

【００５９】以下、Ｙ色の画像の印刷ドット、及びＫ色の画像の印刷ドットについても同様である。従って、当＊頁１頁でのＹ色トナーの消費量、Ｋ色トナーの消費量は、Ｙ色のトナーの係数をＫｙ、Ｋ色のトナーの係数をＫｋとして、それぞれ

Ｙ色トナー消費量＝Ｋｙ×｛ｋ１×（孤立ドットの個数の計数値）
＋ｋ２×（２連続ドットの発生回数の計数値）
＋ｋ３×（３連続ドットの発生回数の計数値）
＋ｋ４×（中間値ドットの個数の計数値）｝
＋Ｙ色トナーのオフセット量 …(11)

Ｋ色トナー消費量＝Ｋｋ×｛ｋ１×（孤立ドットの個数の計数値）
＋ｋ２×（２連続ドットの発生回数の計数値）
＋ｋ３×（３連続ドットの発生回数の計数値）
＋ｋ４×（中間値ドットの個数の計数値）｝
＋Ｋ色トナーのオフセット量 …(12)

となる。

【００６０】なお、上記の各パターンに対する重み付け係数ｋ１、ｋ２、ｋ３、ｋ４及び各色のトナーの係数Ｋｙ、Ｋｍ、Ｋｃ、Ｋｋの値は、種々の画像について印刷を行い、そのときに記録用紙に印刷された各色のトナー量を実測し、その実測されたトナー量と、そのときの印刷した画像の各色の印刷ドット列の孤立ドットの個数、２連続ドットが発生する回数、３連続ドットが発生する回数、中間値ドットの個数との関係等に基づいて定めればよい。

【００６１】上記の(9)～(12)式では４つのパターンに対する重み付け係数ｋ１、ｋ２、ｋ３、ｋ４の値は同じ値を用いるものとしているが、トナーの色によって特性が異なるので、トナーの色によって、孤立ドットのパターンに対する重み付け係数、２連続ドットのパターンに対する重み付け係数、３連続ドットのパターンに対する重み付け係数、及び中間値ドットのパターンに対する重み付け係数は異ならせてもよいものである。また、上記の説明では第２の閾値はＣ、Ｍ、Ｙ、Ｋについて全て同じであるとしたが、色によって異ならせてもよいものである。なお、このようにして求めた各色のトナーの消費量は種々に用いることができることは上述したと同様である。

【００６２】以上のようであるので、このトナー消費量検出方法では、印刷画像の各色の印刷ドット列のパターンを孤立ドット、２連続ドット、３連続ドット、及び中間値ドットの４種類に分け、孤立ドットの個数、２連続ドットの発生回数、３連続ドットの発生回数、中間値ドットの個数を計数し、それら４つの計数値にそれぞれのパターンに対する重み付け係数を乗算して加算し、その加算値にトナーの色に応じた係数を乗算し、その乗算値にオフセット量を加算するという処理を行えばよいので、後述するように簡単な構成で実現することができる。また、このトナー消費量検出方法は、印刷ドット列に基づいてトナー消費量の検出を行うので、レーザ光を駆動するためのパルスを生成するパルス変調方式に因らず、ＰＷＭを用いる装置にも、パルス振幅変調（ＰＡＭ）方式を用いる装置にも、あるいはＰＷＭとＰＡＭを組み合わせたハイブリッド構成の装置にも適用することができる。

【００６３】［第２のトナー消費量検出方法を採用したトナー消費量検出装置］次に、上述した第２のトナー消費量検出方法によりトナー消費量の検出を行うトナー消費量検出装置の一実施形態を説明する。なお、ここでは１印刷ドットは６ビット構成であるとする。

【００６４】図４は、トナー消費量検出装置をカラーレーザプリンタに適用した場合の一実施形態の部分ブロック図を示す図である。図４に示す構成は図２に示すものと同様であるが、その一部の動作が異なっている。図４において、１１はトナー消費量検出装置、１２はドット配列パターン判別回路（以下、単に判別回路と称す）、１３は第２カウンタ、１４は演算回路を示す。なお、図４において、図２に示すものと同じものについては同一の符号を付して重複する説明を最小限にとどめることにする。また、ここではカラーレーザプリンタは、１つの感光体の周囲にＣ、Ｍ、Ｙ、Ｋの４色の現像器が配置されたタイプのものであるとするが、このタイプのカラーレーザプリンタの全体の構成は周知であり、しかも本発明の本質ではないので、図４では感光体や現像器等については図示を省略している。

【００６５】判別回路１２は、第１比較回路２と第２比較回路３とから順次入力される印刷ドットの値の列に基づいて、印刷ドットの値が第１の閾値以上である場合、印刷ドットの値が第２の閾値以上である場合、３連続ドットが発生している場合、孤立ドットである場合の４つの場合を判別するものであり、階調値が第２の閾値以上の印刷ドットを検知する度毎に第１カウンタ５に１を出力し、３連続ドットが発生したことを検知する度毎に第２カウンタ１３に１を出力し、孤立ドットを検知する度毎に第３カウンタ７に１を出力し、階調値が第１の閾値以上である印刷ドットを検知する度毎に第４カウンタ８に１を出力する。

【００６６】第１カウンタ５、第２カウンタ１３、第３カウンタ７、第４カウンタ８は、それぞれ、判別回路１２から１が出力されると、１だけカウントアップする動作を行う。なお、これら４つのカウンタには、それぞれ、図示しないカラー画像形成の処理を司る制御部から制御信号が通知される。この制御信号には、印刷ドットの転送開始を通知するスタート信号と、印刷ドットの転送終了を通知するエンド信号がある。そして、これら４つのカウンタは、スタート信号を受けると、判別回路１２からの出力の計数を開始し、エンド信号受けると計数値を演算回路１４に渡して計数値をクリアする。従って、例えば図３（ａ）に示すような印刷ドットの配列があるとすると、判別回路１２は、第１カウンタ５に対しては図１（ｃ）の第１カウンタの欄の黒丸で示すように、２番目、６～１０番目、１３番目の印刷ドットのときにそれぞれ１を出力することになり、従って図１（ａ）に示す印刷ドット列の期間における第１カウンタ５での計数値は７となる。第２カウンタ１３、第３カウンタ７、第４カウンタ８についても同様である。

【００６７】演算回路１４には、図示しないカラー画像形成の処理を司る制御部から制御信号が通知される。この制御信号には、現在行われているプロセスがどの色のものであるかを示す色信号、印刷ドットの転送開始を通知するスタート信号、及び印刷ドットの転送終了を通知するエンド信号がある。従って、演算回路１４は第１～第４カウンタから計数値を受けるが、演算回路１４は制御部からの色信号により、各カウンタから受け取った計数値が、どの色の画像についてのものであるかを認識している。

【００６８】そして、演算回路１４は、第１カウンタ～第４カウンタから受けた計数値に基づいて、孤立ドットの個数の計数値、２連続ドットの発生回数の計数値、３連続ドットの発生回数の計数値、及び中間値ドットの個数の計数値を求める。孤立ドットの個数の計数値は第３カウンタ７の計数値そのものである。３連続ドットの発生回数の計数値は第２カウンタ１３の計数値そのものである。また、２連続ドットの発生回数の計数値は、第１カウンタ５の計数値から第２カウンタの計数値と第３カウンタの計数値を引いた値で求めることができる。更に、中間値ドットの個数の計数値は、第４カウンタ８の計数値から第１カウンタ５の計数値を引いた値で求めることができる。

【００６９】そして、演算回路１４は、孤立ドットの個数の計数値、２連続ドットの発生回数の計数値、３連続ドットの発生回数の計数値、中間値ドットの個数の計数値の４つの計数値に、それぞれ、それぞれのパターンに対する重み付け係数ｋ１、ｋ２、ｋ３、ｋ４を乗算して、これら４つの値を加算し、更にその加算値にトナーの色に応じた係数を乗算し、更にそれにトナーの色に応じたオフセット量を加算して、今回のプリントにおける当該色のトナー消費量を求める。なお、これら４つのパターンに対する重み付け係数ｋ１、ｋ２、ｋ３、ｋ４の値、各色のトナーの係数Ｋｙ、Ｋｍ、Ｋｃ、Ｋｋの値、及び各色のオフセット量は予め演算回路１４に設定されている。

【００７０】以下、動作を説明するが、ここでは、カラー画像形成のプロセスはＣ、Ｍ、Ｙ、Ｋの順序に行われるものとする。まず、Ｃのカラー画像形成のプロセスが行われるが、このとき第１カウンタ５～第４カウンタ８には制御部からスタート信号が通知され、演算回路１４には制御部から、Ｃのカラー画像形成であることを示す色信号とスタート信号が通知される。

【００７１】そして、Ｃの画像の印刷ドットの転送が開始され、この印刷ドットは、第１比較回路２、第２比較回路３、及びパルス変調回路１０に入力される。パルス変調回路１０では一つ一つの印刷ドットの値に基づいてパルス変調が行われ、生成されたパルスはレーザ駆動部（図４には図示せず）に供給される。

【００７２】また、第１比較回路２は、入力する印刷ドットの値が第１の閾値Ｖｔｈ１以上の場合には、その印刷ドットの値を判別回路１２に出力し、第２比較回路３は、入力する印刷ドットの値が第２の閾値Ｖｔｈ２以上である場合には、この印刷ドットの値を判別回路１２に出力する動作を行う。

【００７３】そして、判別回路１２は、第１比較回路２と第２比較回路３とから順次供給される印刷ドットの値の列に基づいて、印刷ドットの値が第１の閾値以上である場合、印刷ドットの値が第２の閾値以上である場合、３連続ドットが発生している場合、孤立ドットである場合の４つの場合を判別するものであり、階調値が第２の閾値以上の印刷ドットを検知する度毎に第１カウンタ５に１を出力し、３連続ドットが発生したことを検知する度毎に第２カウンタ１３に１を出力し、孤立ドットを検知する度毎に第３カウンタ７に１を出力し、階調値が第１の閾値以上である印刷ドットを検知する度毎に第４カウンタ８に１を出力する動作を行う。

【００７４】第１カウンタ５～第４カウンタ８は、スタート信号を受けてからエンド信号を受けるまでの間、判別回路１２から１が出力される度毎にカウントアップする動作を繰り返す。そして、第１カウンタ５～第４カウンタ８は、エンド信号を受けると、そのときの計数値を演算回路１４に渡して計数値をクリアし、次の計数動作の待機を行う。

【００７５】演算回路１４は、第１カウンタ５～第４カウンタ８から計数値を受けると、当該計数値はＣの画像の印刷ドットについての計数値であることを認識しているから、第１カウンタ５の計数値をｃ１、第２カウンタ１３の計数値をｃ２、第３カウンタ７の計数値をｃ３、第４カウンタ８の計数値をｃ４として、次の式によりこのときのＣ色トナーの消費量を求める。

C色トナー消費量＝Kc×｛k1×c3＋k2×（c1－c2－c3）＋k3×c2
＋k4×（c4－c1）｝＋C色トナーのオフセット量　…(13)

ここで、k1は孤立ドットのパターンに対する重み付け係数、k2は２連続ドットのパターンに対する重み付け係数、k3は３連続ドットのパターンに対する重み付け係数、k4は中間値ドットのパターンに対する重み付け係数である。

【００７６】このようにしてCの画像形成のプロセスが終了すると、次に、Mの画像形成が行われ、その次に、＊Yの画像形成のプロセスが行われ、更にKの画像形成のプロセスが行われるが、演算回路１４はこれらの画像形成プロセス時にも同様にして、M色のトナー消費量、Y色のトナー消費量、K色のトナー消費量を次の式により演算する。

M色トナー消費量＝Km×｛k1×c3＋k2×（c1－c2－c3）＋k3×c2
＋k4×（c4－c1）｝＋M色トナーのオフセット量　…(14)

Y色トナー消費量＝Ky×｛k1×c3＋k2×（c1－c2－c3）＋k3×c2
＋k4×（c4－c1）｝＋Y色トナーのオフセット量　…(15)

K色トナー消費量＝Kk×｛k1×c3＋k2×（c1－c2－c3）＋k3×c2
＋k4×（c4－c1）｝＋K色トナーのオフセット量　…(16)

【００７８】上述したように、４つのパターンに対する重み付け係数k1、k2、k3、k4の値、及び各色のトナーの係数Ky、Km、Kc、Kkの値は実験により求めることができるが、本発明者の実験によれば、１印刷ドットが６ビット構成、第２の閾値Vth2＝４８としたとき、

k1＝0.76　…(17)

k2＝1.00　…(18)

k3＝1.10　…(19)

k4＝0.30　…(20)

$Kc = 9.20 \times 10^{-6}$　…(21)

$Km = 10.50 \times 10^{-6}$　…(22)

$Ky = 9.95 \times 10^{-6}$　…(23)

$Kk = 12.53 \times 10^{-6}$　…(24)

が得られた。これらの値を用いて(13)～(16)式の演算を行えば、各色のトナー消費量をｍｇの単位で求めることができることが確認された。

【００７９】なお、以上の例では、１つのレーザ光でC、M、Y、Kの４色の静電潜像を１つの感光体に形成するタイプのカラーレーザプリンタに適用した場合について説明したので、各色のトナー消費量の演算は、１つの色画像の形成プロセス毎に行っているが、感光体と現像器のセットを４つ備える、いわゆるタンデムタイプのものに適用する場合には、C、M、Y、Kの４つの画像形成プロセスの系統にそれぞれこのトナー消費量検出装置を設ければよいので、１回のプリント単位にトナー消費量を演算するようにすることも勿論可能であるが、ジョブ単位、あるいは１日単位等の適宜な単位でトナー消費量の演算を行うことも可能である。その場合には、４つのカウンタ及び演算回路１４に通知する制御信号の形態を、トナー消費量の演算を行う単位に応じて適宜変更する必要があることは当然である。

【００８０】なお、上記の説明では４つのパターンに対する重み付け係数k1、k2、k3、k4の値は同じ値を用いるものとしているが、トナーの色によって特性が異なるので、トナーの色によって、孤立ドットのパターンに対する重み付け係数、２連続ドットのパターンに対する重み付け係数、３連続ドットのパターンに対する重み付け係数及び中間値ドットのパターンに対する重み付け係数は異ならせてもよいものである。

【００８１】演算回路１４で求めた各色のトナーの消費量のデータの利用の仕方については上述したと同様である。

【００８２】以上のようであるので、このトナー消費量検出装置によれば、簡単な構成で各色のトナー消費量を求めることができ、しかも、どのようなパルス変調方式を用いるものにも適用することが可能である。

【００８３】［実験結果］次に、本発明者が行った実験結果を図５に示す。図５は、風景画等の自然画像、幾何図形等を多く含むグラフィック画像、自然画像とグラフィック画像の両方を含む画像等の種々の画像１９点を印刷したときの１枚ずつのトナー消費量の理論値と、プリント時に実際に消費されたトナー量の実測値との関係を示す図である。なお、この実験においては、１印刷ドットは６ビット構成であり、第１の閾値Vth1＝１、第２の閾値Vth2＝４８である。

【００８４】ここで、トナー消費量の理論値とは、上記(17)～(24)の値を用いて、(13)～(16)式により求めた各色のトナーの消費量である。図５（ａ）はY色トナーの消費量、図５（ｂ）はMトナーの消費量、図５（ｃ）はC色トナーの消費量、図５（ｄ）はK色トナーの消費量を示しており、いずれも横軸が１枚ずつの理論値、縦軸が１枚ずつの実測値であり、単位はｍｇである。また、図５（ａ）～（ｄ）の白丸あるいは黒四角でプロットされている１つ１つがそれぞれプリントを行った画像の１点１点を示しており、図５（ａ）～（ｄ）のそれぞれには１９点がプロットされている。また、図５（ａ）には「ｙ＝1.0000ｘ－0.0002」という方程式が記載されているが、これは横軸をｘ、縦軸をｙとしたときの図５（ａ）に示す直線の方程式である。また、図５（ａ）には「R^2＝0.9831」という記載があるが、これはプロットされている１９点について理論値と実測値の相関関係を求めたときの相関係数である。図５（ｂ）～（ｄ）についても同様である。

【００８５】そこで図５（ａ）～（ｄ）を見れば、全ての色のトナーについて、理論値と実測値の相関係数は１に近く、プロットされている点は一つの直線の上によく乗っていることが分かる。これは、即ち、理論値が実測値とよく合っていることを示しているに他ならない。

【００８６】次に、図５と比較のために図６を示す。図６は、図５で印刷したと同じ画像１９点を印刷したときのトナー消費量の理論値と、プリント時に実際に消費されたトナー量の実測値との関係を示す図である。この実験においても１印刷ドットあｈ６ビット構成であり、第１の閾値Vth1＝１であるが、第２の閾値Vth2＝６３となされている。即ち、この実験では、第２の閾値は最大階調値となされているのである。なお、方程式の意味、相関係数の意味は図５と同じである。

【００８７】図６（ａ）～（ｄ）をみると、直線から離れているプロットがあること、相関係数が図５に示すものより悪いことが分かる。以上のことから、１印刷ドットが６ビット構成の場合、第２の閾値を階調値で４８とすることが有用であることが分かる。

【００８８】このように、１印刷ドットが６ビット構成の場合、第２の閾値Vth2を階調値で４８とし、印刷ドット列のパターンを、孤立ドット、２連続ドット、３連続ドット、中間値ドットの４つのパターンに分け、(9)～(12)式によって精度よくトナー消費量を検出することができることについての理論的な説明は非常に難しいが、概略次のようなことはいえると考えられる。

【００８９】１印刷ドットが６ビット構成の場合、上述したように、階調値が４８というのは図７においてＰで示すように、レーザ発光時間とトナー消費量の関係を示すグラフにおけるレーザ発光時間が長い方の変曲点近傍の階調値に対応していることが確認されている。そして、閾値を設定しようとする場合、一般的にはグラフの変曲点あるいはその近傍の値を採用することが多いことはよく知られている。また、図７の実線の特性からも明らかなように、Ｐ点以上の階調値の印刷ドットについては消費されるトナー量は同等と考えることができる。以上のことから、１印刷ドットが６ビット構成の場合には第２の閾値を階調値で４８とすることについて妥当性があると考えられる。

【００９０】しかし、上述した理由により、値が第２の閾値以上の印刷ドットであっても、孤立ドットの場合と、２連続ドットの場合と、３連続ドットの場合とを区別するのが望ましい。このことから、値が第２の閾値以上の印刷ドットについては、孤立ドット、２連続ドット、３連続ドットの３つのパターンに分けることの妥当性がある。

【００９１】以上のように、値が第２の閾値以上の印刷ドットについては消費されるトナー量は同等と考えることができるのであるが、図７の実線の特性から、値が第２の閾値未満の印刷ドットについてはそのようなことはいえないので別な取り扱いをしなければならない。これが中間値ドットである。

【００９２】ところで、図７の破線で示すものは実線で示す特性の両端を結んだものであり、レーザ発光時間とトナー消費量の特性が線形である場合であるが、値が小さい中間値ドットのトナー消費量は線形特性の場合より小さく、値が大きい中間値ドットのトナー消費量は線形特性の場合より多いものとなる。このことから、一つ一つの印刷ドットの値についてみると、確かに印刷ドットの値とトナー消費量の関係は非線形なのであるが、画像１枚単位のように多くの印刷ドットを全体としてみた場合には、中間値ドットの値の平均値を取ると、その平均値はある特定の値に収まるのではないかと予想される。そこで、値が第１の閾値以上で、且つ第２の閾値未満である印刷ドットについては、中間値ドットとして一括めで扱うことの妥当性があると考えられる。

【００９３】以上のことから、本発明者は、上述したように、１印刷ドットが６ビット構成の場合、第１の閾値Vth1＝１、第２の閾値Vth2＝４８として、印刷ドット列を、孤立ドット、２連続ドット、３連続ドット、中間値ドットの４種類にパターン分けし、孤立ドットの個数、２連続ドットの発生回数、３連続ドットの発生回数、孤立ドットの個数を計数し、それらの計数値に基づいて(9)～(12)式によって各色のトナー消費量を検出しようとしたのであり、各パターンに対する重み付け係数、及び各色のトナーの係数を実験によって求めたところ、図５に示すような結果を得たのである。

【００９４】以上のようであるので、このトナー消費量検出装置によれば、簡単な構成で精度よく各色のトナーの消費量を求めることができ、しかも、パルス変調方式としてPWMを用いる装置にも、ＰAMを用いる装置にも、ハイブリッド構成のものを用いる装置にも、あるいはその他の方式でパルス変調を行う装置にも適用することができる。

【図面の簡単な説明】

【図１】本発明に係る第１のトナー消費量検出方法を説明すると共に、図２に示すトナー消費量検出装置１のドット配列パターン判別回路４の動作を説明するための図である。

【図２】第１のトナー消費量検出方法によりトナー消費量の検出を行うトナー消費量検出装置の一実施形態を示す図である。

【図３】本発明に係る第２のトナー消費量検出方法を説明すると共に、図４に示すトナー消費量検出装置１１のドット配列パターン判別回路１２の動作を説明するための図である。

23 24

【図４】第２のトナー消費量検出方法によりトナー消費量の検出を行うトナー消費量検出装置の一実施形態を示す図である。

【図５】実験結果を示す図である。

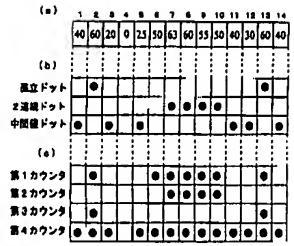
【図６】他の実験結果を示す図である。

【図７】一個の印刷ドットだけを印刷したときのレーザ発光時間と、印刷されたドットに消費されるトナー量との関係の概略を示す図である。

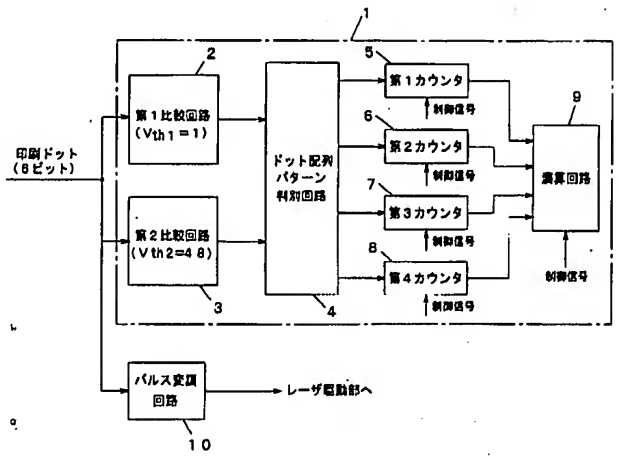
【符号の説明】

１…トナー消費量検出装置、２…第１比較回路、３…第２比較回路、４…ドット配列パターン判別回路、５…第１カウンタ、６…第２カウンタ、７…第３カウンタ、８…第４カウンタ、９…演算回路、１０…パルス変調回路、１１…トナー消費量検出装置、１２…ドット配列パターン判別回路、１３…第２カウンタ、１４…演算回路。

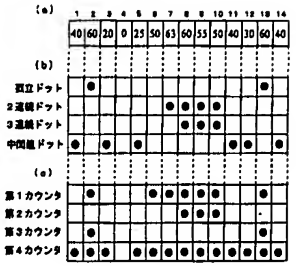
【図１】



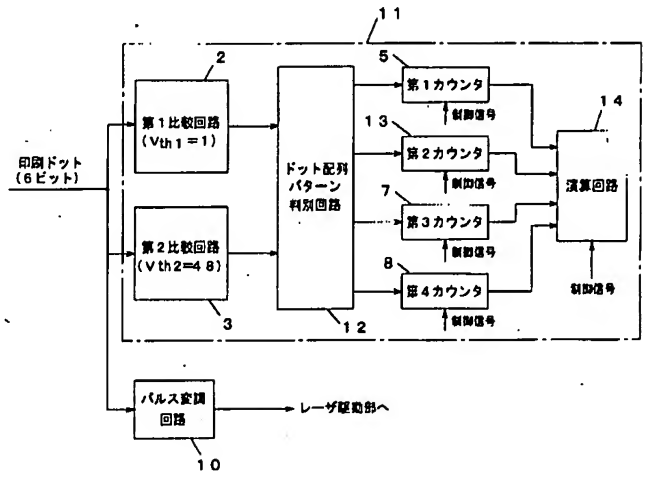
【図２】



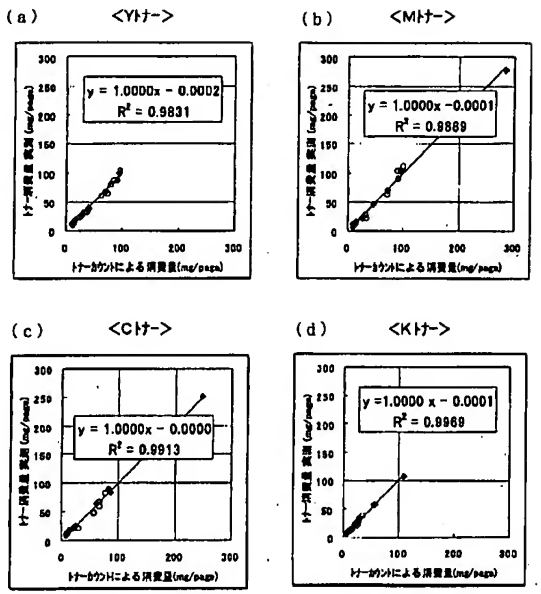
【図３】



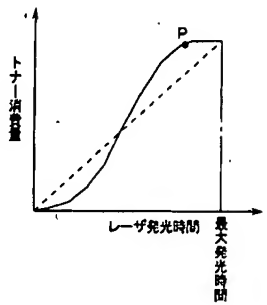
【図４】



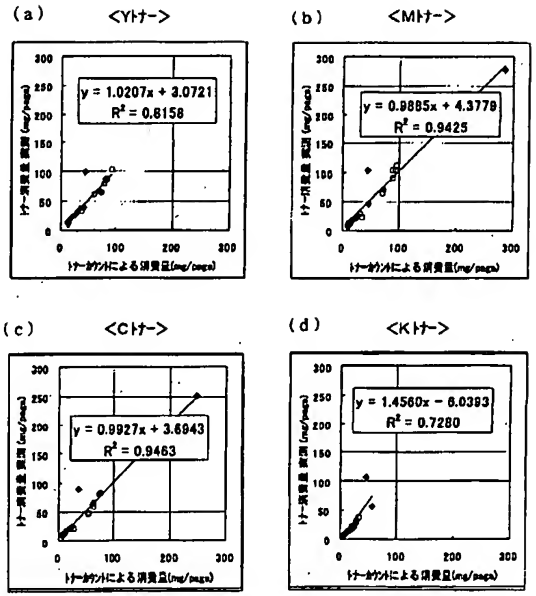
【図５】



【図７】



【図６】



フロントページの続き

Ｆターム(参考) 2C362 CA08 CA16 CA21 CB37 CB80
EA02
2H027 DB01 DD02 DE07 EA06 EB01
EC06
2H030 AD12 AD16 BB36
2H077 DA08 DA15 DA78 DB02 DB14
GA02 GA13